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Assessment of the 1999/2000 and 2000/2001 snow crab (*Chionoecetes opilio*) fishery off southwestern Nova Scotia (NAFO Division 4X)

Évaluation des pêcheries de crabe des neiges (*Chionoecetes opilio*) du sud-ouest de la Nouvelle-Écosse (dans la division 4X de l'OPANO) pour 1999/2000 et 2000/2001

M. Biron, L. Savoie, K. Drinkwater and/et M. Moriyasu

Science Branch
Gulf Region, Department of Fisheries and Oceans
Gulf Fisheries Centre
P.O. Box 5030
Moncton, N.B., E1C 9B6

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Abstract

The management measures in 1999 and in the first 9 months of 2000 remained similar to those in 1998, however in the fall of 2000, the existing 4 exploratory permits were converted into permanent licenses. Overall, landings (213 t), average CPUEs (13.7 kg/th) and total effort (15,568 th) have increased during the 2000 / 2001 fishing season compared to the same period in 1999 / 2000 (119 t, 9.8 kg/th and 12,038 th, respectively). This fishery operated in a competitive manner and without a quota. Therefore, landings were neither distributed equally among fishermen, nor evenly distributed between the two fishing grounds. Less than 15 t were harvested in the Roseway Basin and the remaining in the LaHave area.

The available snow crab biomass for this Area is unknown and there is no scientifically justifiable data to determinate a TAC (total allowable cath) limit. The use of CPUE and effort as indexes of abundance from this fishery is limited because average CPUEs and estimated total effort are greatly affected by the existing differences between gear types, fishing grounds, and in the effort deployed by each individual/license within a fishing season or for any given year (fishing season).

Sampling for female and undersized male (< 95 mm CW) snow crab, using shrimp traps, was carried out in 2000 in cooperation with the participating fishermen. Results show the presence of adolescent males (30% of catch) and females (7% of catch) in the LaHave area.

Résumé

Les mesures de gestion de 1999 et des 9 premier mois de 2000 sont demeurées similaires à celles de 1998. Cependant, à l'automne de 2000, les 4 permits exploratoires existants on été convertit en licenses permanentes. Dans l'ensemble, les débarquements (213 t), la PUE moyenne (13.7 kg/casier levé) et l'effort total (15,568 casiers levés) ont augmentés durant la saison de pêche de 2000/2001 lorsque comparé à la même période en 1999/2000 (119 t, 9.8 kg/casier levé et 12,038 casiers levés, respectivement). Cette pêcherie s'est déroulée de manière compétitive et sans quota. Par conséquent, les débarquements n'ont pas été répartis également entre les pêcheurs, ni entre les lieux de pêche. Moins de 15 t ont été pêchés dans le basin Roseway, alors que le reste provenait de la région de LaHave.

La biomasse de crabe des neiges est inconnue pour cette zone, et il n'y a pas de données scientifiques valables qui permetteraient de déterminer un TPA (total des prises allouées) limite. L'utilisation de la PUE et de l'effort en tant qu'indices d'abondance pour cette pêcherie est limité par le fait que l'estimation de la PUE moyenne et de l'effort total est grandement influencé par les différences existant entre les types d'engin de pêche, entre les lieux de pêche, et entre l'effort déployé par chaque individu / license à l'intérieur d'une saison de pêche et/ou entre chaque année.

L'échantillonnage de femelles et de males sous-légaux (< 95 mm LC) de crabe des neiges à l'aide de casiers à crevettes a été réalisé en coopération avec les pêcheurs en 2000. Les résultats ont démontrés la présence d'adolescents males (30% de la capture) et de femelles (7% de la capture) dans la région de LaHave.

INTRODUCTION

Harvesting of snow crab, *Chionoecetes opilio*, in Area 4X (NAFO Division 4X; Fig. 1), off the southwestern coast of Nova Scotia, began in 1994. From 1994 to the fall of 2000, this fishery was managed on a yearly basis, but starting in 2000 a new fishing season was introduced which ran from November 1st to June 1st. Therefore, past data and fishery historic were revisited based on this new season (i.e. September 1st of one year to July 31st of the following year). As a consequence, the first half of these new 'fishing periods' (i.e. fall of a given year) may have different management measures than the second half (i.e. spring / summer of the following year).

Historic – In August 1994, four fishermen received temporary permit conditions which included a 30 trap limit, no females retained, male snow crab greater than 95 mm CW, by-catch of Jonah crab allowed, and exploratory crab logbooks to be submitted. In 1995, fishing effort started in March and the 4 permit holders were allowed to use 100 traps of which 30 could be 6 feet in diameter instead of the standard 4 feet in diameter. Permission to retain Northern Stone crab by-catch was also added to the permit conditions. The reported snow crab landings for the 1994/95 fishing period were 17 t and the seasonal catch-per-unit-effort (CPUE) was estimated at 1.8 kg/th.

In 1996 three of the four licenses were renewed, and in August one was issued to a replacement fisherman chosen from the eligibility list. The trap limit changed to 250 of which 30 could be the larger-size traps. By-catches of Jonah crab and Northern Stone crab were again allowed with the size limits of 130 mm and 95 mm CW, respectively. Traps were required to have a biodegradable panel, and 10% dockside monitoring (DMP) was required. A performance criterion was introduced to the fishery and was set at 18 sea days per year, which was based on 10% of the available fishing days in the previous fishing season. The fishermen had to exceed this limit to maintain their snow crab permit. Overall, effort reached 11,146 trap hauls during the 1995/96 season and a large portion of Area 4X was explored, but often trap catches were equal to zero. The reported snow crab landings were 11 t and the average CPUE was estimated at 1.0 kg/th.

In 1996/97, reported snow crab landings were 4 t and the seasonal CPUE was estimated at 1.0 kg/th. All four permits were renewed in 1997 and the only major change from 1996 was an increase in the DMP coverage to 20%. Only two permit holders have fished in 1997, one of whom fished for Jonah crab instead of snow crab. The effort was reduced (3,475 trap hauls) in 1996/97 compared to 1995/96 season.

In 1998, Jonah crab was no longer allowed as a by-catch species in this exploratory snow crab fishery, while DMP coverage remained at 20% as required by the developing species policy now implemented in the region. A high concentration of snow crab was found along the NAFO fishing boundary 4W/4X. This resulted in the relocation of the fishing effort of three fishermen to that area from the fishing grounds surrounding Brown, Baccaro, and Roseway Banks. The fourth fisherman maintained his exploratory fishing activity as usual in the Roseway Basin area. Trap limit was restricted to a maximum of 30 large traps in Halifax and Lunenburgh Counties during 1998 due to the high CPUEs and concentration of fishing

activity in this area. Furthermore, the overall limit of 250 traps was reduced to 175, of which 30 could be large-sized ones. The reported landings for the 1997/98 fishing period rose rapidly to 42 t, while the total effort decreased by 30 to 15% (7,893 trap hauls) compared to 1995/96 and 1994/95, respectively. In 1997/98, the seasonal CPUE increased to 5.3 kg/th compared to the usual 1 to 2 kg/th observed in previous years.

Current status - The management measures in 1999 and in the first 9 months of 2000 remained similar to those in 1998. However in the fall of 2000, a decision was made by Fishery Management to convert the 4 exploratory permits in existence since 1994 into permanent licenses. As a result, Northern Stone crab was dropped as an allowed by-catch species in this area. Two temporary permits were issued to native bands in the fall of 1999 and in the spring of 2000 (December to February), but no fishing activities were ever reported in Area 4X from these bands. The first official fishing season was set for November 1st 2000 to June 1st 2001, and was based on fishing preference by the current fishermen. The industry felt that the crab quality was better during the colder months of the year. A minimum coverage of the at-sea Observer Program is now imposed and was established at a total of 12 trips for the 2000-2001 fishing season.

MATERIALS AND METHODS

Landings, CPUE and effort

In 1999, 2000, and 2001, data on landings and fishing effort were obtained from the mandatory logbook completed by all fishermen for both dockside monitoring and the scientific database. Copies of the original logs and the compiled electronic database were obtained from the Statistic Division of the Maritimes Region of the Department of Fisheries and Oceans. Total annual landings for each year were obtained from revised preliminary report produced by the Statistics Division.

Annual versus seasonal – Since the fall of 2000, the official fishing season for this area has been set from November to June, spreading the data over 2 calendar years. Therefore, both annual and seasonal fishery data are being compiled and presented for discussion. Annual refers to the period between January 1st to December 31st of a given year, while seasonal refers to the period of time between September 1st of one year to July 31st of the following year. All annual data have been put in the appendix section.

Landings - Annual landings are the sum of the landings from the logs received for Area 4X in a given year. Seasonal landings are the sum of landings from the logs received between September of a given year to July of the following year. Weekly landings are the sum of landings from the logs received for a period starting on Sunday to the following Saturday. Annual, seasonal and weekly landings were calculated for different fishing grounds and the fishing positions were taken from the logs.

CPUE and effort - The average CPUE for Area 4X corresponds to the ratio of the sum of the landings (y) to the sum of the number of trap haul (th) needed to catch these respective

landings, as reported only in properly completed logs: CPUE = $\sum y / \sum th$. The total effort (total number of trap hauls) was then estimated from the sum of all landings (Y) (including landings from improperly completed logbooks) divided by seasonal CPUE: total effort = Y / CPUE. Average CPUEs were calculated on an annual, seasonal, and weekly basis, as well as by fishing grounds. The fishing positions were taken from the logs.

Sea sampling

Sea sampling data were collected by DFO technicians and by certified observers. For each randomly-sampled trap, the total number of male crabs, the position and depth of the trap were recorded, and a sub-sample of 20 to 40 crabs was taken randomly for the following measurements: carapace width (CW) and claw height (ChH) using modified vernier calipers (Watson and Wells 1970); for carapace hardness (CH) using a hardness gauge (Foyle et al. 1989), and for carapace condition (CC), which were categorized into five groups (Appendix I; Moriyasu et al. 1998). New-soft (stage I) and clean crab (stage II) with CH < 68 is considered as a postmolt soft-shelled crab (Moriyasu et al. 1998). The terminology of male maturity phase follows Sainte-Marie et al. (1995). Adult (terminal molt) and adolescent (non-terminal molt) individuals can be identified using chela morphometry by plotting logarithms (ln) of ChH against ln of CW (Conan and Comeau 1986). Data from adult and adolescent crabs fit into two distinct ellipses with parallel major axes (Conan and Comeau 1986). The following discriminant function was calculated for ENS male snow crab (Biron et al., 1999):

$$Y = 19.775707 \ln(ChH) - 25.324040 \ln(CW) + 56.649941$$

will assign individuals to the correct groups in 99% of cases (for adult males: Y > 0).

Shrimp trap survey

In an attempt to verify the presence of female and juvenile male snow crabs, as well as to gather biological data, a survey using unmodified shrimp trap was conducted in the spring of 2000. Each fisherman was responsible to set and fish 3 shrimp traps in his current fishing ground. These traps were to be fished 24 to 48 hours later, and all crab specimens were conserved in coolers and brought back to the Moncton DFO laboratory for detailed analysis.

Biological sampling – For each trap, the total number of male and female crabs, the position, and the depth were recorded. All specimen collected were transported to the laboratory in Moncton, N.B. The following measurements were taken: CW, ChH, weight (*w*), condition of the carapace (CC: on a scale of 1 to 5), and the hardness of the right claw measured with a durometer, for the males; CW, *w*, the width of the fifth abdominal segment (AW), and the color of the eggs and gonads, for the females.

RESULTS

Annual fishery data

1999

Fishing effort distribution – The pattern of fishing effort distribution in 1999 was similar to 1998, with 3 fishermen concentrating their effort along the NAFO fishery boundary 4X/4W, while the fourth remained near the Roseway Basin (Fig. 2).

Landings - Total landings in 1999 were estimated at 91 t, representing a 117% increase compared to 1998 (Tables 1 and 2 in Appendix 2). Landings occurred mainly during the first half of the year, from January 1 to July 31, 1999 (Figs. 1 and 2 in Appendix 3).

CPUE and effort - The annual CPUE was 13.4 kg/th (Table 2 in Appendix 2; Figs. 2 and 3 in Appendix 3). The total effort was 6,826 trap hauls, which represent a 15% decrease in fishing effort compared to 1998 (Table 1 in Appendix 2; Figs. 2 and 4 in Appendix 3).

2000

Fishing effort distribution – Fishing distribution in 2000 was similar to 1999. Two fishermen concentrated their effort along the NAFO fishery boundary 4X/4W, another permanent fisherman remained near the Roseway Basin, while the fourth permanent license holder moved between the two existing fishing grounds (Fig. 3).

Landings - Total landings in 2000 were estimated at 160 t (Tables 1 and 3 in Appendix 2), representing a 75% increase compared to 1999, and the highest annual landing to date for this exploratory fishery (Figs. 1 and 2 in Appendix 3).

CPUE and effort - The annual CPUE was estimated at 11.5 kg/th (Table 3 in Appendix 2; Figs. 2 and 3 in Appendix 3). The total effort was 13,865 trap hauls, which represent over 100% increase in fishing effort compared to 1999 (Table 1 in Appendix 2; Figs. 2 and 4 in Appendix 3).

2001

Fishing effort distribution – The pattern of fishing effort distribution during the first half of 2001 was similar to 1999, with 3 fishermen concentrating their effort along the NAFO fishery boundary 4X/4W, while the fourth one remained around the Roseway Basin (Fig. 4). In the fall of 2001, 5 license holders started their new fishing season with all the effort currently directed towards the LaHave area.

Landings - Total landings for the first 11 months of 2001 were estimated at 287 t (Tables 1 and 4 in Appendix 2; Figs. 1 and 2 in Appendix 3).

CPUE and effort - The annual CPUE of 15.2 kg/th was similar to 2000 (Table 4 in Appendix 2; Figs. 2 and 3 in Appendix 3). The total effort to date was 18,872 trap hauls (Table 4 in Appendix 2; Figs. 2 and 4 in Appendix 3).

Seasonal fishery data

1999 - 2000

Landings - Total landings for the 1999-2000 fishing season were estimated at 119 t (Tables 1 and 2; Fig. 5) of which 27 t were caught in the Roseway Basin area and over 91 t were caught in LaHave Basin area (Tables 3 and 4). The seasonal weekly landings illustrate well the difference in quantity of the snow crab exploitation between the two fishing grounds, with LaHave Basin area being by far the most productive (Fig. 6).

CPUE and effort – The overall seasonal CPUE was 9.8 kg/th in 1999-2000 (Tables 1 and 2; Figs. 7 and 8), but the breakdown by fishing area showed an estimated 16.4 kg/th for the LaHave Basin area and 4.1 kg/th for the Roseway Basin (Tables 3 and 4). The total seasonal effort was 12,038 trap hauls, of which 5,570 were completed in the LaHave area and 6,604 in the Roseway area (Tables 1, 2, 3 and 4, Fig. 8). Again, average weekly CPUEs and total effort clearly showed majors differences between the 2 current fishing grounds with the highest CPUE and effort in the LaHave Basin Area (Figs. 9 and 10).

2000 - 2001

Landings - Total landings for the 2000-2001 fishing season were estimated at 213 t (Tables 1 and 2; Fig. 5), and of which 199 t were caught in the LaHave Basin area and 14 t in Roseway Basin area (Tables 3 and 4). Seasonal weekly landings for the 2000 / 2001 fishing season showed a similar distribution pattern to the 1999 / 2000 season (Fig. 6).

CPUE and effort – The overall seasonal CPUE in 2000-2001 was 13.7 kg/th (Table 1 and 2; Fig. 7 and 8), and the breakdown by fishing area showed an estimated 16.6 kg/th for the LaHave Basin and 3.4 kg/th for the Roseway Basin area (Tables 3 and 4). The total seasonal effort was 15,537 trap hauls, of which 11,929 were found in the LaHave area and 4,027 in the Roseway area (Tables 1, 2, 3 and 4; Fig. 8). Average weekly CPUEs were higher during the fall of 2000 than in 1999 (Fig. 9), while there was more effort put in this fishery during the fall 2000 and spring 2001 than for the same period in 1999 - 2000 (Fig. 10).

Fishing grounds and trap types

Fishing locations in 1999, 2000 and 2001 clearly show two main fishing grounds in Area 4X: the Roseway Basin area and the LaHave Basin area (Fig. 1). During the 1999/2000 season, 1 fisherman fished exclusively in the Roseway Basin area, 2 fishermen fished exclusively in the LaHave area, while the 4th one fished both fishing grounds. During the 2000/2001 fishing season, 1 fishermen exploited exclusively the Roseway area, while the other 3 fishermen remained in the LaHave area.

Logbook data and at-sea observer data indicated only two types of trap used on these fishing grounds: 1- the Japanese type (4 feet diameter conical), which is the most common type being currently used by 3 of the 4 fishermen. It has been used on both fishing grounds during the 1999/2000 and 2000/2001 fishing seasons. The number of trap is limited to 175, and 2- the low cone type (6 feet diameter conical) which is currently used solely by 1 fisherman. This type was used on both fishing grounds during the 1999/2000 fishing season, and only in the LaHave area during the 2000/2001 season. The number of this trap type is limited to 30.

In order to illustrate the relationship and the differences the type of gear and the fishing locations has on the seasonal and annual CPUEs presented in this document, logbook data were analyzed according to the type of gear and the fishing locations during the 1999/2000 and 2000/2001 fishing seasons. CPUEs are generally 2 to 4 times lower in the Roseway area than the LaHave area, depending on the gear type being used (Table 5). The average CPUEs of Japanese traps in the LaHave area was 7.4 kg/ and 9.3 kg/th during the 1999/2000 and 2000/2001 fishing seasons, while it was 38.4 and 44.5 kg/th respectively for the low cone traps (Table 5). In the case of the Roseway Basin area, the average CPUEs of Japanese traps was 3.8 kg/ and 3.5 kg/th during the 1999/2000 and 2000/2001 fishing seasons, while it was 10.7 kg/th for the low cone traps during the 1999/2000 fishing season (Table 5).

At-sea Observer data

Roseway Basin area – Catch composition derived from the at-sea samples collected July 19, 2000 showed that 85% of the measured crabs were adult males ≥ 95 mm CW (Table 6, Fig. 11 and table 1 in Appendix 4), similar to the 82% found in 1999. Adolescent males accounted for 7% of the catches in 2000, compared to none found in 1999. The average soft-shell crab percentage was 5% in 2000, compared to 2% in 1999. The proportion of undersized adult males was 8% in 2000, a two fold decrease over 1999. In 2000, the mean CW of 103.9 mm is bigger than the 101.8 mm found in 2001, but lower than the 104.9 mm CW reported in 1999.

LaHave Basin area – Sampling during the winter of 2001 shows that on average the percentages of adolescent and adult snow crab remained fairly constant each month at 2% and 98%, respectively (Table 7 and Tables 2 and 3 in Appendix 4). Low percentage of soft-shelled crabs were found in February and March (< 1%), while it increased to 14% in April (Table 7 and 8). The percentage of undersized male adults was the lowest in February at 8%, increased to 33% in March, and was around 25% in April (Table 7). The mean CW was 101.6 mm (Fig. 12) and overall 3 trips were covered by DFO-observers for a total of 43 traps sampled and 736 crabs measured.

Similar results, although based on a'string of traps' instead of 'by trap', were found by certified at-sea observers during the month of April 2001. In this case, the average rates of adolescent and adult crabs was 3 and 97%, respectively, while the amount of undersized adult males was 15% (Table 8 and Table 2 and 3 in Appendix 4). The mean CW was 100.3 mm CW (Figs. 13), while overall, 4 trips were covered by observers for a total of 17 strings sampled and 571 crabs measured.

Shrimp trap survey

Female snow crab - Twenty-five females snow crab were caught with shrimp traps on May 17, 2000 in the Roseway Basin area, and 81 females were caught on May 23, 2000 in the LaHave Basin area. Shrimp traps were also used in the LaHave area on August 10, 2000, but only 1 female was caught and it was not used for analysis. Excepted for 10 barren females (N=99), all mature females carried orange eggs. In the Roseway Basin area, all 25 females caught were adults ranging from 56.2 to 82.6 mm CW (mean CW = 68.4 mm), and were mostly carapace condition 4 and 5 (Fig. 14). In the LaHave Basin area, the 81 females captured ranged in CW from 45.3 to 81.4 mm (mean = 65.8 mm), and mostly of carapace condition 3 and 4 (Fig. 14). The plotting of the AW over the CW showed the presence (and distinction) of immature females (which were all caught in the LaHave area)(Fig. 15).

Recruitment and adolescent males – No adolescent or juvenile male snow crab were caught with the shrimp traps in the Roseway Basin. In the LaHave Basin area, the majority (>95%) of males caught in the shrimp traps were smaller than 95 mm, with 1/3 of the catch being juvenile and adolescent, while the rest was undersized adults (Fig. 14). Distribution of the carapace condition showed that most of the male crabs were of CC 3 and 3M (Fig. 14). Plotting of the ChH against the CW illustrate both the adolescent and adult groups (Fig. 16).

DISCUSSION

There are important considerations to be made before interpreting the 2000/2001 fishery-related data and indices in relation with those of any previous year and/or those of other snow crab fishing areas. Among the most important, there is the change from exploratory permit status to permanent licenses and the creation of a defined fishing season (November 1st to June 1st), the difference between the commercially exploitable fishing grounds currently harvested in Area 4X, and the differences in the type of gear being used by fishermen, as well as with the gear used in other fishing areas. Each of these factors is discussed below. Overall, landings (213 t), average CPUE (13.7 kg/th) and total effort (15,568 th) have increased during the 2000 / 2001 fishing season compared to the same period in 1999 / 2000 (119 t, 9.8 kg/th and 12,038 th, respectively). This fishery operated in a competitive manner and without a quota. Therefore, landings are not distributed equally among fishermen, with the difference between the highest and lowest landings being 100 t in 2000/2001. Furthermore, landings were not evenly distributed between the two fishing grounds, with less than 15 t harvested in the Roseway Basin and the remaining in the LaHave area.

Fishing season and permanent status

From 1994 to the beginning of 2000, this fishery was considered exploratory and, therefore, did not have any specific season and fishermen were allowed to fish year round (Biron et al. 2000). Except in 1995, when a high level of effort was applied throughout the year in finding commercial snow crab concentrations, the bulk of the fishery always happens in the

late winter months. Although previous documents have compared the data collected during this fishery on an annual basis, the limitation of a November to June fishing season makes it more logical to compare data on a seasonal (fishing season) basis rather than annual. Otherwise, to tally the data on a yearly basis for any given year is to tally the data from the end of a given fishing season with the beginning of the following fishing season. Although both annual and seasonal fishery data are being compiled and presented for discussion, the seasonal data should be used for comparison from year to year and for management purposes.

The change in the status of the 4 original exploratory permits to permanent licenses has resulted in an increase for fishing activity during the 2000/2001 season. This is not associated with the stock status, when compared to previous fishing seasons, but to the change of status itself. In recent years, 2 of the 4 permits were being exploited only for a 30 days period every year, usually in late winter, because the permit owners were unable to fish themselves. In this case, being an exploratory fishery, the regulation allowed the owner to hire a temporary replacement for 30 days or less without any risk of loosing their permits. The permanent status has resulted in the sale of these 2 permits, and they have been utilized without any time restrictions during the 2000/2001 fishing season.

CPUEs and effort

Seasonal CPUE has increased from 9.8 kg/th in 1999 / 2000 to 13.7 kg/th in 2000/2001. However, interpreting CPUE in Area 4X is extremely difficult because until 2001 there was only 4 fishermen split between two fishing grounds and using two different types of traps. CPUE was dependent of the type of gear used, of the fishing ground being exploited, as well as the amount of fishing activity deployed by each fishermen in any given season. Change in behavior from 1 fisherman can significantly affect weekly, monthly or annual average CPUE for the Area. Add to this the fact there was no time limitation (i.e. restricted to 30 days) on any of the licenses in 2000 / 2001 compared to previous years, and that large trap type were fished on both fishing grounds previous to, but not in to 2000 / 2001 where they were deployed only in LaHave area (better CPUE). Only this in itself would justify some of the increase in CPUE and total effort observed in 2000 / 2001 compared to 1999 / 2000. Preliminary data from 2001-2002 season showed no effort in the Roseway Basin area, and at least one license that was previously fished only with smaller traps is now being fished with large conical traps.

Gear types and fishing grounds: Up until the fall of 2001, 3 permanent fishermen preferred using the Japanese traps, with one of them always fishing in the Roseway Basin area and the other 2 always fished in the LaHave area. The fourth permanent fisherman preferred using 6 feet diameter conical traps and fished both areas. CPUE for small conical trap during the last 2 fishing seasons was 3 and 5 times lower compared to that for larger trap types in the Roseway Basin area and in the LaHave area, respectively. Mean CPUE of small traps was 2 to 2.5 times lower in the Roseway Basin area than the LaHave area, while mean CPUE of large traps were 3.6 times lower in the Roseway Basin compared with the LaHave area. There is a marked difference in CPUE between the two gear types, but also between the two fishing grounds.

Roseway Basin area - Fishing activities began in mid-February in 1999 / 2000 and 2000 / 2001, and stopped by the end of July and end of May, respectively. Overall, there seems to be no general pattern in the average CPUEs and/or effort distribution throughout the fishing season, with both remaining relatively low and constant. The comparison of both seasons showed a 48% decrease in landings, a 15% decrease in CPUE, and a 40% decrease in effort. However, omitting the second fishermen present in this area in 1999 / 2000 from the comparison still showed a 40% decrease in landings, a 10% decrease in average CPUE, and 35% decrease in effort. In 2000, the 2 highest average weekly CPUE obtained with the larger trap types for this area were 14 and 20 kg/th. These were the exception since all the other weekly CPUEs were under 7 kg/th. This fishing area did not contribute to the record highest landings and total effort observed during the 2000/2001 snow crab season.

LaHave Basin area - Fishing activities in 1999/2000 and 2000/2001 began in November and stopped by the end of May. Average weekly CPUE and effort from the low cone traps were similar to the general pattern found in other snow crab fisheries in ENS. For example, the average weekly CPUE of the larger trap types at the beginning of the season was 61.4 kg/th in 1999 / 2000 and 84.0 kg/th in 2000/2001, and decreased progressively to 30.0 kg/th by the end of both seasons. However, the average weekly CPUE of Japanese traps in 2000 / 2001 fluctuated mostly between 5 to 10 kg/th from November to January, then increased to an averages of 10 to 20 kg/th during February, and then decreased to weekly average of 5 to 10 kg/th by the end of the season. Weekly CPUE pattern for 2000 / 2001 showed a high CPUE at the beginning of the season that quickly dropped when a fisherman with Japanese traps started his fishing activity in mid-November, and further dropped with the arrival of another fishermen in January, to then increase during the month of February, to finally fluctuate between 10 to 20 kg/th until the end of the season.

Population structure and recruitment

Commercial fishery - The catch composition established from the sampling of the commercial fishery in 2000 and 2001 showed a low percentage of adolescent males (2 to 3.5%) which was similar to the 3.9% reported in 1999 (Biron et al. 2000). There was very little difference in the catch composition between the Roseway Basin area and the LaHave Basin area. The majority of the crabs captured were of carapace condition 3 and 4.

Only 1 adult male snow crab was caught with the shrimp traps in the Roseway Basin area, which indicated that adolescent crabs were scarce. However in the LaHave area, 30% of the male caught with the shrimp traps were adolescent varying in size from 41 to 101 mm. This clearly indicates that recruitment for this fishery was present in LaHave area at the time of the survey. However, recruitment to this fishery is likely to also originate from the eastern Scotian Shelf or the southern Gulf of St. Lawrence where some of the adolescent and adult crabs probably migrate into this area from eastward grounds (Area 24). But most of the recruitment probably arrives when the snow crabs are at the larval stage and free floating. Davidson et al. (1985) reported no genetic difference between eastern and western Cape Breton stocks, and suggested that genetic homogeneity was maintained by larval transport. Since the larval period lasts approximately 3 months, and given the unidirectional surface

current flowing northeast – southwest on the Scotian Shelf (Davis and Brown 1997), a substantial number of larvae hatched off eastern Nova Scotia must be transported towards Area 4X. The distribution of advanced stages of snow crab larvae on the Scotian Shelf also suggested that larvae are transported southerly from eastern Cape Breton (Roff et al., 1986; Tremblay et al., 1994).

Discriminant functions – The discriminant function developed for snow crab males in ENS, and the one for the females in the Gulf of Saint Lawrence, worked properly with the snow crab stock found in Area 4X. Unless otherwise proved in the future, these discriminant functions will be used for all biological data analysis collected by the at-sea Observer Program or DFO personal.

Environmental Factors

In winter, heat losses to the atmosphere and the outflow of frigid water from the Gulf of St. Lawrence reduce the temperatures of the surface waters on the Scotian Shelf, to near 0.5°-2°C in the southwest. In summer, seasonal heating produces a warm upper layer (14°-17°C). In the central and southwestern regions of the shelf where depths exceed approximately 100 m or more, this produces a three-layer system, with this warm surface layer overlaying a cold intermediate layer (~4°C in summer) and below that a deeper warm layer. The latter originates from Offshore Slope Waters that are transported onto the shelf. Higher salinities in this warm deep layer maintain a stable water column. Bottom temperatures in Roseway Basin are typically 4°-6°C while in the deeper LaHave Basins they are 8°-10°C, indicative of the greater influence of the offshore Slope Waters.

Two types of Slope Water can persist along the offshore edge of the Scotian Shelf. Warm Slope water with temperatures typically > 8°C has dominated the region during the past 30 years. Subsequently, the waters in the deep basins on the shelf have reflected its presence. At times, however, cold (4°-8°C) Labrador Slope Water flows into the region from the north and replaces the Warm Slope Water. Such an event occurred in 1998 and persisted for approximately 1 year. Once along the shelf edge, the cold Labrador Slope Water soon penetrated onto the shelf through channels and gullies. It displaced the Warm Slope Water that had occupied the deep basins of the Scotian Shelf and Gulf of Maine and also covered much of the bottom of the southwestern Scotian Shelf. In 1998, the central and southwestern Scotian Shelf experienced the coldest near-bottom temperatures in the over 30-year record of groundfish surveys. In 1999, the Warm Slope Water returned to the shelf edge and gradually the shelf waters warmed up. By late 1999 or early 2000, deep temperatures had returned to above the long-term mean. Given that snow crab prefer colder-than-average bottom temperatures and the warming of the near-bottom temperatures, bottom environmental conditions have become less favourable for crab compared to 1998 and 1999 but are similar to conditions observed in the mid-1990s.

Annual means near-bottom temperatures on the southeastern Scotian Shelf in the region of the LaHave Basin where snow crab are fished (Fig. 17) vary with depth. At 100 m, they are near 4.5°C with a typical seasonal range from approximately 3.5° to 5.5°C. These temperatures tend to be 1°-2°C cooler than those found at depths in Roseway Basin where

snow crabs are caught. During 2001, temperatures in both of these regions were generally colder than their long-term (1971-2000) average conditions. They also cooled relative to 2000 and are similar to the colder-than-average temperatures observed during the late-1980s through the 1990s. Given that colder-than-average bottom temperatures are considered to be preferred by snow crab in these regions, the conditions in 2001 indicate a return to more favourable temperatures for snow crab compared to 2000 and are similar to most of the 1990s.

CONCLUSIONS, RECOMMENDATIONS AND OUTLOOK

1. The available snow crab biomass for this Area is unknown and there is no robust scientific information to determinate a TAC level;

2. The use of CPUE and effort as indices of abundance for this fishery is doubtful;
   - Because average CPUEs and estimated total effort are greatly affected by the existing differences between gear types; and
   - Because the fishing season of 2000 / 2001 is actually the first time since the snow crab 'appeared' in the LaHave area in 1998 that all licenses were possibly exploited to their full potential in term of fishing effort. As such, it should be considered as more representative of the stock status, but not as direct evidence that stock status has 'improved' since the last assessment; and
   - Because the Japanese traps may be saturated around 15 to 20 kg/th, which is often reached. In this case, there is no way to compare the relative abundance corresponding to the CPUE higher than 15-20 kg/th.

3. Area 4X is at the southern most limit of the natural distribution of snow crab. The snow crab habitat is limited to 2 small areas of 'colder' summer bottom temperature (4-7°C) currently being exploited: the Roseway Basin and an area north of LaHave Basin. Therefore, this fishery would be more susceptible to sudden environmental changes. And in that respect, the Roseway Basin fishing grounds would be more susceptible than the LaHave Basin ones.

4. The Roseway Basin has been the least productive fishing ground. Constant low CPUEs and catches since 1994, compared to the LaHave Basin area in recent years, have been the norms for this fishing ground. The comparison of the 2000 / 2001 Roseway Basin data with those of 1999 / 2000 shows a 48% decrease in landings, a 15% decrease in CPUE and a 40% decrease in effort.

5. Doubling of the effort and landings in the LaHave Basin area in 2000 / 2001, compared to 1999 / 2000, can be attributed to the change of the 4 original exploratory permit status to permanent licenses (i.e. no 30-day limitation on any licenses in 2000 / 2001).

6. Based on the current available information on the biological and fishery status of this fishery, it should still be considered as a sporadic fishery with a portion of the commercial size males migrating from the northern Scotian Shelf when the biomass is at high levels.

The quantity of migrating biomass, nor the proportion of resident recruitment contributing to the fisheries has not been assessed so far and may considerably vary from year to year.

7. Marked differences in CPUE between the Japanese and low cone traps may be reflecting the fishing power difference between the two types of traps, while the differences in CPUE between the two fishing grounds may be reflecting the relative abundance difference of the two commercial fishing grounds. A comparison of the two types of traps is recommended since it would help in the interpretation of the CPUE results.

8. A trawl survey of the LaHave area is being considered, and might start as early as 2002.

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REFERENCES

Biron, M., M. Moriyasu, E.Wade, P. DeGrâce, R. Campbell and M. Hébert. 1999. Assessment of the 1998 snow crab (*Chioecetes opilio*) fisheries off eastern Nova Scotia (Areas 20 to 24 (and 4X)), Canada. CSAS Res. Doc. 1999/12.

Biron, M., R. Campbell and M. Moriyasu. 2000. Historical review (1994-1998) and assessment of the 1999 exploratory snow crab (*Chionoecetes opilio*) fishery off southwestern Nova Scotia (NAFO Division 4X). CSAS Res. Doc. 2000/18.

Conan , G.Y. and M. Comeau. 1986. Functional maturity of male snow crab, (*Chionoecetes opilio*). Can. J. Fish. Aquat. Sci. 43 : 1710-1719.

Davidson, K., J.C. Roff and R.W. Elner. 1985. Morphological, electrophoretic, and fecundity characteristics of Atlantic snow crab, *Chionoecetes opilio*, and implications for fisheries management. Can. J. Fish. Aquat. Sci. 42(3): 474-482.

Davis, D.S. and S. Brown. 1997. The natural history of Nova Scotia. Vol. 1: Topics and habitat. Nova Scotia Museum.

Foyle, T.P., G.V. Hurley, and D.M. Taylor. 1989. Field testing shell hardness guages for the snow crab fishery. Can. Ind. Rep. Fish. Aquat. Sci. 193.

Moriyasu, M., E. Wade, A. Sinclair and Y. Chiasson. 1998. Snow crab, *Chionoecetes opilio*, stock assessment in the southwestern Gulf of St. Lawrence by bottom trawl survey. *In* Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management. *Edited by* G.S. Jamieson and A. Campbell. Can. Spec. Publ. Fish. Aquat. Sci. 125. Pp. 29-40.

Roff, J.C., L.P. Fanning and A.B. Stasko. 1986. Distribution of larval crabs (Decapoda: Brachyura) on the Scotian Shelf. Can. J. Fish. Aquat. Sci. 43:587-599.

Sainte-Marie, B., S. Raymond and J.-C. Brêthes. 1995. Growth and maturation of the benthic stages of male snow crab, *Chionoecetes opilio* (Brachyura: Majidae). Can. J. Fish. Aquat. Sci. 52: 903-924.

Tremblay, M.J., M.D. Eagles and R.W. Elner. 1994. Catch, effort and population structure in the snow crab fishery off eastern Cape Breton, 1978-1993: a retrospective. Can. Tech. Rep. Fish. Aquat. Sci. 2021.

Watson, J. and P.G. Wells. 1970. A gauge for carapace measurements of crabs. J.Fish. Res. Board Can. 27: 1158-1161.

Table 1. Seasonal landings, catch rate and effort statistics for Snow Crab (*Chionoecetes opilio*) for southwestern Nova Scotia (Exploratory NAFO 4X), 1994-2001.

Season	Active Licences/permits	Total* landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (trap haul)
1994/1995	4	17	1.8	9,406
1995/1996	4	11	1.0	11,146
1996/1997	4	4	1.0	3,475
1997/1998	4	42	5.3	7,893
1998/1999	4	70	11.8	5,986
1999/2000	4	119	9.8	12,038
2000/2001	6	213	13.7	15,568
Average (all)		68	6.3	9,359
Average (99/00-00/01)		166	11.8	13,803

* Total seasonal landing statistics provided by DFO-Statistics, Halifax.

Table 2. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X for the 1999/2000 and 2000/2001 seasons.

1999/2000				2000/2001			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)	Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Oct. 24	-	-	-	Oct. 22	-	-	-
Oct. 31	-	-	-	Oct. 29	6,826	68.3	100
Nov. 7	1,841	61.4	30	Nov. 5	7,138	84.0	85
Nov. 14	3,241	54	60	Nov. 12	5,441	44.9	121
Nov. 21	2,587	47	55	Nov. 19	17,115	31.0	552
Nov. 28	3,008	50.1	60	Nov. 26	3,333	66.7	50
Dec. 5	3,272	44.8	73	Dec. 3	7,476	28.3	264
Dec. 12	2,521	31.5	80	Dec. 10	6,584	23.9	275
Dec. 19	2,893	36.2	80	Dec. 17	5,027	12.6	400
Dec. 26	1,569	39.2	40	Dec. 24	3,364	67.3	50
Jan. 2	1,105	24.6	45	Dec. 31	5.245	12.6	415
Jan. 9	1,519	38	40	Jan. 7	6,857	12.4	555
Jan. 16	-	-	-	Jan. 14	6,399	11.3	565
Jan. 23	2,603	34.7	75	Jan. 21	10,648	12.5	850
Jan. 30	5,134	19.6	262	Jan. 28	5,573	13.9	400
Feb. 6	3,325	47.5	70	Feb. 4	6,744	9.0	750
Feb. 13	3,713	9.8	380	Feb. 11	3,157	35.1	90
Feb. 20	4,055	9.9	410	Feb. 18	3,748	11.7	319
Feb. 27	2,713	6.8	400	Feb. 25	15,254	13.3	1,144
Mar. 5	9,812	9.9	995	Mar. 4	9,401	9.1	1,036
Mar. 12	4,140	7.7	540	Mar. 11	13,309	12.4	1,077
Mar. 19	9,934	8.7	1,136	Mar. 18	6,977	12.1	579
Mar. 26	5,665	8.6	662	Mar. 25	5,822	8.1	719
Apr. 2	6,830	9.6	708	Apr. 1	5,270	7.5	700
Apr. 9	4,693	14.0	335	Apr. 8	7,565	7.1	1,064
Apr. 16	3,605	10.9	332	Apr. 15	9,761	11.3	864
Apr. 23	957	5.0	191	Apr. 22	6,287	10.2	614
Apr. 30	2,599	10.0	261	Apr. 29	8,400	11.7	717
May 7	1,722	8.7	197	May 6	7,661	10.7	715
May 14	3,692	9.4	392	May 13	1,309	29.1	45
May 21	3,194	8.1	392	May 20	5,055	11.2	453
May 28	1,075	17.9	60	May 27	321	?	?
June 4	629	2.5	256	June 3	-	-	-
June 11	1,970	4.1	483	June 10	-	-	-
June 18	2,620	5.4	483	June 17	-	-	-
June 25	2,563	5.3	483	June 24	-	-	-
July 2	2,468	5.2	477	July 1	-	-	-
July 9	1,705	4.8	353	July 8	-	-	-
July 16	1,734	3.4	510	July 15	-	-	-
July 23	1,314	2.8	474	July 22	-	-	-
July 30	445	2.8	158	July 29	-	-	-
Total*	118,465	9.8	12,038	Total*	213,067	13.7	15,568

*Total seasonal landings

Table 3. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X for the 1999/2000 and 2000/2001 seasons for the LaHave Basin Area.

1999/2000				2000/2001			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)	Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Oct. 24	-	-	-	Oct. 22	-	-	-
Oct. 31	-	-	-	Oct. 29	6,826	68.3	100
Nov. 7	1,841	61.4	30	Nov. 5	7,138	84.0	85
Nov. 14	3,241	54	60	Nov. 12	5,441	44.9	121
Nov. 21	2,587	47	55	Nov. 19	17,115	31.0	552
Nov. 28	3,008	50.1	60	Nov. 26	3,333	66.7	50
Dec. 5	3,272	44.8	73	Dec. 3	6,510	28.3	230
Dec. 12	2,521	31.5	80	Dec. 10	5,251	52.5	100
Dec. 19	2,893	36.2	80	Dec. 17	4,381	19.5	225
Dec. 26	1,569	39.2	40	Dec. 24	3,364	67.3	50
Jan. 2	1,105	24.6	45	Dec. 31	4,290	17.9	240
Jan. 9	1,519	38	40	Jan. 7	6,857	12.4	555
Jan. 16	-	-	-	Jan. 14	6,399	11.3	565
Jan. 23	2,603	34.7	75	Jan. 21	10,648	12.5	850
Jan. 30	5,134	19.6	262	Jan. 28	5,573	13.9	400
Feb. 6	3,325	47.5	70	Feb. 4	6,744	9.0	750
Feb. 13	3,713	9.8	380	Feb. 11	3,157	35.1	90
Feb. 20	3,625	9.5	380	Feb. 18	3,700	21.8	170
Feb. 27	2,542	7.3	350	Feb. 25	14,344	14.4	995
Mar. 5	9,791	10.3	955	Mar. 4	8,428	11.4	740
Mar. 12	3,655	9.4	390	Mar. 11	12,405	15.9	780
Mar. 19	9,253	11.5	805	Mar. 18	6,355	14.8	430
Mar. 26	4,996	11.9	420	Mar. 25	4,466	10.6	420
Apr. 2	5,423	12.9	420	Apr. 1	3,578	8.9	400
Apr. 9	4,058	21.4	190	Apr. 8	6,463	8.5	764
Apr. 16	3,166	45.2	70	Apr. 15	9,092	12.7	714
Apr. 23	160	5.3	30	Apr. 22	5,543	22.0	252
Apr. 30	-	-	-	Apr. 29	7,945	19.1	417
May 7	1,158	33.1	35	May 6	7,298	17.5	416
May 14	2,543	36.3	70	May 13	1,309	29.1	45
May 21	2,183	31.2	70	May 20	4,912	23.7	208
May 28	469	13.4	35	May 27	321	?	?
June 4	-	-	-	June 3	-	-	-
June 11	-	-	-	June 10	-	-	-
June 18	-	-	-	June 17	-	-	-
June 25	-	-	-	June 24	-	-	-
July 2	-	-	-	July 1	-	-	-
July 9	-	-	-	July 8	-	-	-
July 16	-	-	-	July 15	-	-	-
July 23	-	-	-	July 22	-	-	-
July 30	-	-	-	July 29	-	-	-
Total*	91,353	16.4	5,570	Total*	199,186	16.7	11,948

*Total seasonal landings

Table 4. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X for the 1999/2000 and 2000/2001 seasons for the Roseway Basin Area.

1999/2000				2000/2001			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)	Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Oct. 24	-	-	-	Oct. 22	-	-	-
Oct. 31	-	-	-	Oct. 29	-	-	-
Nov. 7	-	-	-	Nov. 5	-	-	-
Nov. 14	-	-	-	Nov. 12	-	-	-
Nov. 21	-	-	-	Nov. 19	-	-	-
Nov. 28	-	-	-	Nov. 26	-	-	-
Dec. 5	-	-	-	Dec. 3	966	?	?
Dec. 12	-	-	-	Dec. 10	1,333	7.6	175
Dec. 19	-	-	-	Dec. 17	646	3.7	175
Dec. 26	-	-	-	Dec. 24	-	-	-
Jan. 2	-	-	-	Dec. 31	955	5.5	175
Jan. 9	-	-	-	Jan. 7	-	-	-
Jan. 16	-	-	-	Jan. 14	-	-	-
Jan. 23	-	-	-	Jan. 21	-	-	-
Jan. 30	-	-	-	Jan. 28	-	-	-
Feb. 6	-	-	-	Feb. 4	-	-	-
Feb. 13	-	-	-	Feb. 11	-	-	-
Feb. 20	430	14.3	30	Feb. 18	48	0.3	149
Feb. 27	171	3.4	50	Feb. 25	910	6.1	149
Mar. 5	21	0.5	40	Mar. 4	973	3.3	296
Mar. 12	485	3.2	150	Mar. 11	904	3.0	297
Mar. 19	681	2.1	331	Mar. 18	622	4.2	149
Mar. 26	669	2.8	242	Mar. 25	1,356	4.5	299
Apr. 2	1,407	4.9	288	Apr. 1	1,692	5.6	300
Apr. 9	635	4.4	145	Apr. 8	1,102	3.7	300
Apr. 16	439	1.7	262	Apr. 15	669	4.5	150
Apr. 23	797	5.0	161	Apr. 22	744	2.1	362
Apr. 30	2,599	10.0	261	Apr. 29	455	1.5	300
May 7	564	3.5	162	May 6	363	1.2	299
May 14	1,149	3.6	322	May 13	-	-	-
May 21	1,011	3.1	322	May 20	141	0.8	172
May 28	606	3.8	161	May 27			
June 4	629	2.5	256	June 3			
June 11	1,970	4.1	483	June 10			
June 18	2,620	5.4	483	June 17			
June 25	2,563	5.3	483	June 24			
July 2	2,468	5.2	477	July 1			
July 9	1,705	4.8	353	July 8			
July 16	1,734	3.4	510	July 15			
July 23	1,314	2.8	474	July 22			
July 30	445	2.8	158	July 29			
Total*	27,112	4.1	6,604	Total*	13,879	3.4	4,027

*Total seasonal landings

Table 5. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X for the 2001/2002 seasons.

2001/2002			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Oct. 21	-	-	-
Oct. 28	11,541	35.0	330
Nov. 4	34,801	24.4	1,424
Nov. 11	23,096	28.8	801
Nov. 18	46,673	26.8	1,742
Nov. 25	15,401	59.0	261
Dec. 2	4,553	9.1	500
Dec. 9	-	-	-
Dec. 16	-	-	-
Dec. 23	-	-	-
Dec. 31	-	-	-
Jan. 6	-	-	-
Jan. 13	-	-	-
Jan. 20	-	-	-
Jan. 27	-	-	-
Feb. 3	-	-	-
Feb. 10	-	-	-
Feb. 17	-	-	-
Feb. 24	-	-	-
Mar. 3	-	-	-
Mar. 10	-	-	-
Mar. 17	-	-	-
Mar. 24	-	-	-
Mar. 31	-	-	-
Apr. 7	-	-	-
Apr. 14	-	-	-
Apr. 21	-	-	-
Apr. 28	-	-	-
May 5	-	-	-
May 12	-	-	-
May 19	-	-	-
May 26	-	-	-
June 2	-	-	-
June 9	-	-	-
June 16	-	-	-
June 23	-	-	-
June 30	-	-	-
July 7	-	-	-
July 14	-	-	-
July 21	-	-	-
July 28	-	-	-
Aug. 4	-	-	-
Total*	136,875	27.1	5,058

*Total seasonal landings

Table 6. Difference in CPUEs (kg/th) between the different trap types and fishing grounds found in Area 4X.

	LaHave fishing grounds		Roseway fishing grounds	
Trap types	1999/2000	2000/2001	1999/2000	2000/2001
Japanese	7.4	9.3	3.8	3.5
low cone	38.4	44.5	10.7	-

Table 7. Catch composition, in percentage, from at-sea samples (number of trips and traps sampled) in the Roseway Basin Area for southwestern Nova Scotia in 2000-2001.

a) Catch composition (%) for July 19, 2000 in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		Adolescent	adult	adolescent	adult	adolescent	Adult	
1	13	< 95 mm	1.2	8.3	0.0	0.0	1.2	8.3	9.5
		> 95 mm	3.6	82.1	2.4	2.4	6.0	84.5	90.5
		total	4.8	90.5	2.4	2.4	7.1	92.9	100.0

b) Catch composition (%) for May 12, 2001in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		Adolescent	adult	adolescent	adult	Adolescent	Adult	
1	22	< 95 mm	0.9	31.1	0.0	0.0	0.9	37.1	32.1
		> 95 mm	0.9	67.0	0.0	0.0	0.9	67.0	67.9
		total	1.9	98.1	0.0	0.0	1.9	98.1	100.0

c) Catch composition (%) for May 22, 2001 in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		Adolescent	adult	adolescent	adult	Adolescent	Adult	
1	41	< 95 mm	0.0	14.6	0.0	0.0	0.0	14.6	14.6
		> 95 mm	1.9	83.5	0.0	0.0	1.9	83.5	85.4
		total	1.9	98.1	0.0	0.0	1.9	98.1	100.0

d) Catch composition (%) in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		Adolescent	adult	adolescent	adult	Adolescent	Adult	
3	76	< 95 mm	0.7	18.8	0.0	0.0	0.7	18.8	19.5
		> 95 mm	2.0	77.1	0.7	0.7	2.7	77.8	80.5
		total	2.7	95.9	0.7	0.7	3.4	96.6	100.0

Table 8. Catch composition (in percentage) from at-sea samples (number of trips and traps sampled) in the LaHave Basin Area for southwestern Nova Scotia in 2001.

a) Catch composition (%) for February 9, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		Adolescent	adult	adolescent	adult	Adolescent	Adult	
1	13	< 95 mm	0.0	8.2	0.0	0.0	0.0	8.2	8.2
		> 95 mm	2.3	88.6	0.0	0.9	2.3	89.5	91.8
		total	2.3	96.8	0.0	0.9	2.3	97.7	100.0

b) Catch composition (%) for March 16, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	Adult	adolescent	Adult	adolescent	Adult	
1	9	< 95 mm	0.6	32.9	0.0	0.6	0.6	33.4	34.0
		> 95 mm	1.4	64.6	0.0	0.0	1.4	64.6	66.0
		total	2.0	97.4	0.0	0.6	2.0	98.0	100.0

c) Catch composition (%) for April 20, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	Adult	adolescent	Adult	
1	21	< 95 mm	1.2	20.4	0.6	4.2	1.8	24.6	26.3
		> 95 mm	0.0	64.1	0.0	9.6	0.0	73.7	73.7
		total	1.2	84.4	0.6	13.8	1.8	98.2	100.0

d) Catch composition (%) in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	Adult	adolescent	Adult	
3	43	< 95 mm	0.5	22.7	0.1	1.2	0.7	23.9	24.6
		> 95 mm	1.4	71.6	0.0	2.5	1.4	74.1	75.4
		total	1.9	94.3	0.1	3.7	2.0	98.0	100.0

Table 9. Catch composition (in percentage) from at-sea samples (number of trips and strings* sampled) in the Lahave Basin Area for southwestern Nova Scotia in 2001.

a) Catch composition (%) for April 5, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	Adult	adolescent	adult	adolescent	adult	
1	5	< 95 mm	0.6	11.3	0.0	0.0	0.6	11.3	11.9
		> 95 mm	0.6	85.6	1.9	0.0	2.5	85.6	88.1
		total	1.3	96.9	1.9	0.0	3.1	96.9	100.0

b) Catch composition (%) for April 12, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	Adult	adolescent	adult	adolescent	adult	
1	2	< 95 mm	0.0	10.1	0.0	0.0	0.0	10.1	10.1
		> 95 mm	2.5	86.1	1.3	0.0	3.8	86.1	89.9
		Total	2.5	96.2	1.3	0.0	3.8	96.2	100.0

c) Catch composition (%) for April 17, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	Adult	adolescent	adult	adolescent	adult	
1	5	< 95 mm	0.0	18.4	1.3	3.9	1.3	22.4	23.7
		> 95 mm	1.3	58.6	0.7	15.8	2.0	74.3	76.3
		Total	1.3	77.0	2.0	19.7	3.3	96.7	100.0

d) Catch composition (%) in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	Adult	adolescent	adult	adolescent	adult	
3	12	< 95 mm	0.3	13.8	0.5	1.5	0.8	15.4	16.1
		> 95 mm	1.3	75.2	1.3	6.1	2.6	81.3	83.9
		total	1.5	89.0	1.8	7.7	3.3	96.7	100.0

*A string can have 10 to 21 traps.

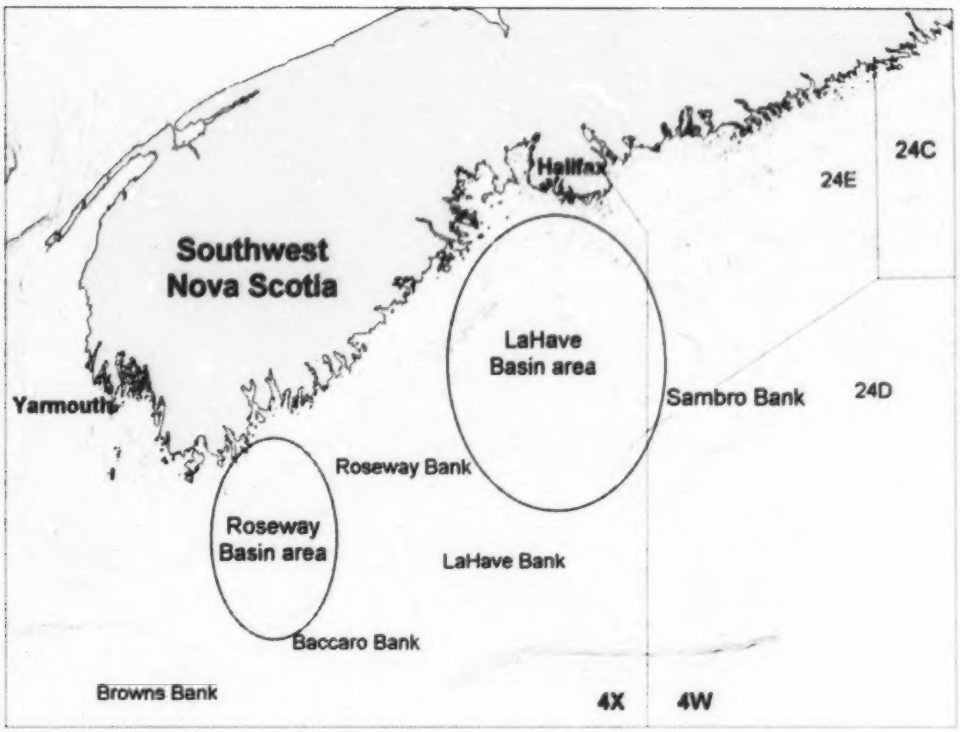

Figure 1. Snow Crab fishing Area 4X (NAFO 4X) off southern Nova Scotia.

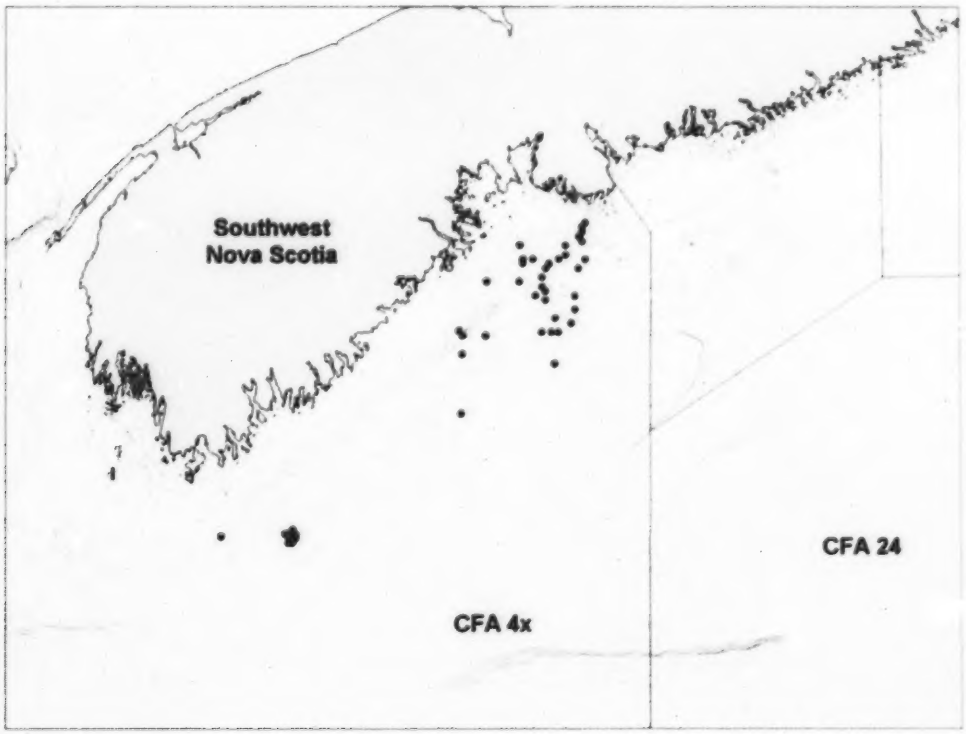

Figure 2. Reported logbook positions in 1999.

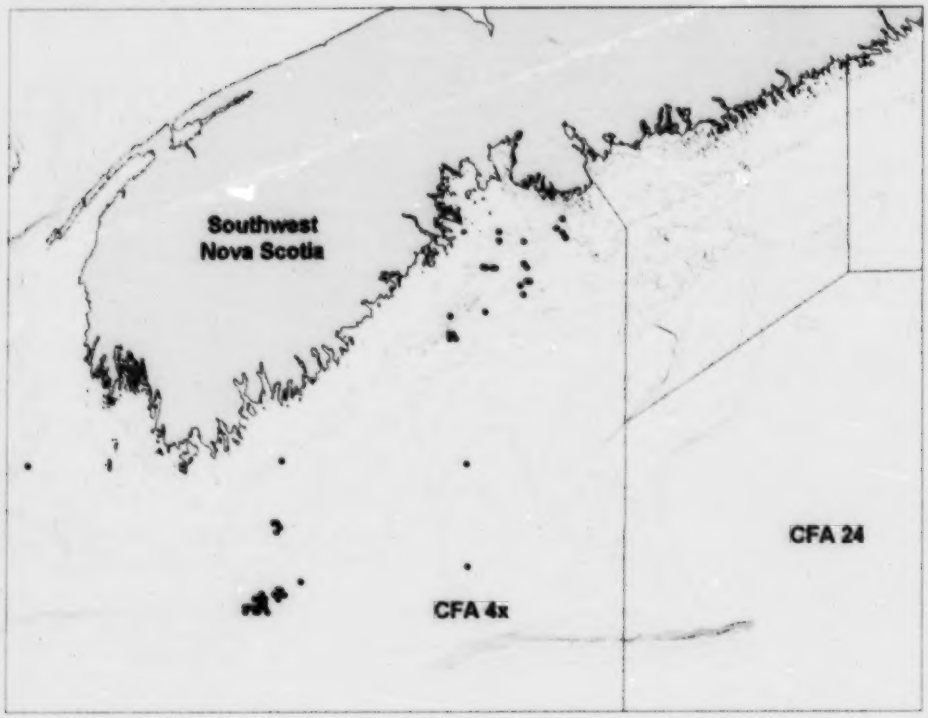

Figure 3. Reported logbook positions in 2000.

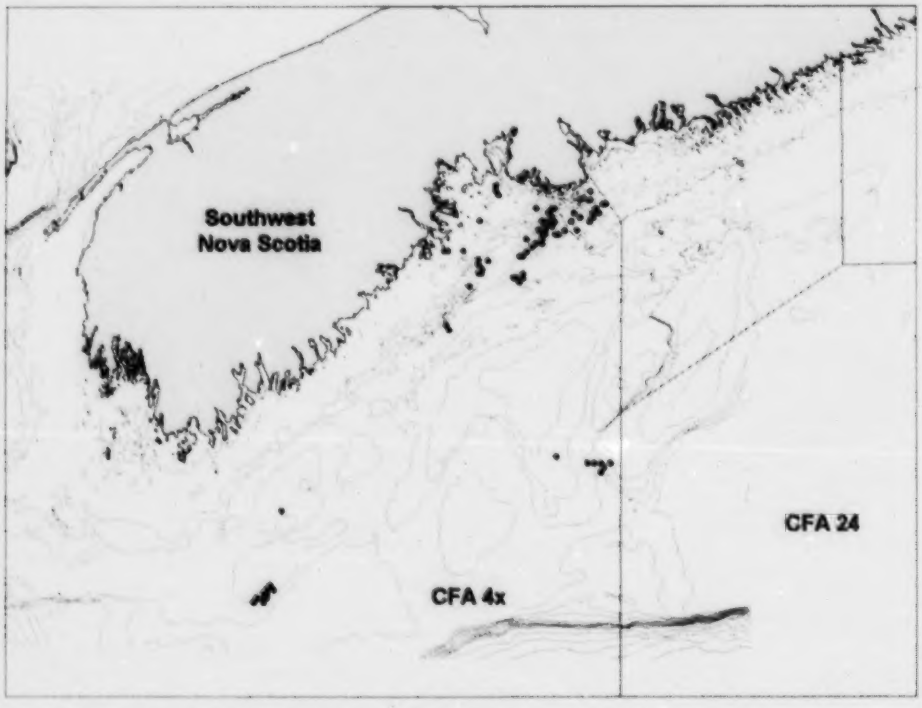

Figure 4. Reported logbook positions in 2001.

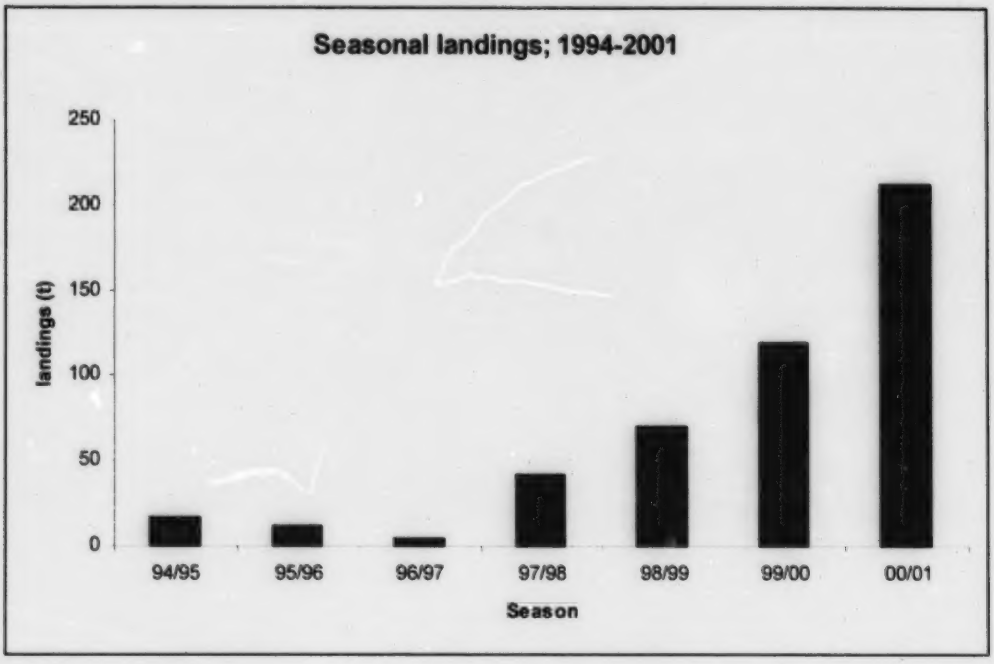

Figure 5. Seasonnal Snow Crab landings (t) in southwestern Nova Scotia from 1994 to May 24, 2001.

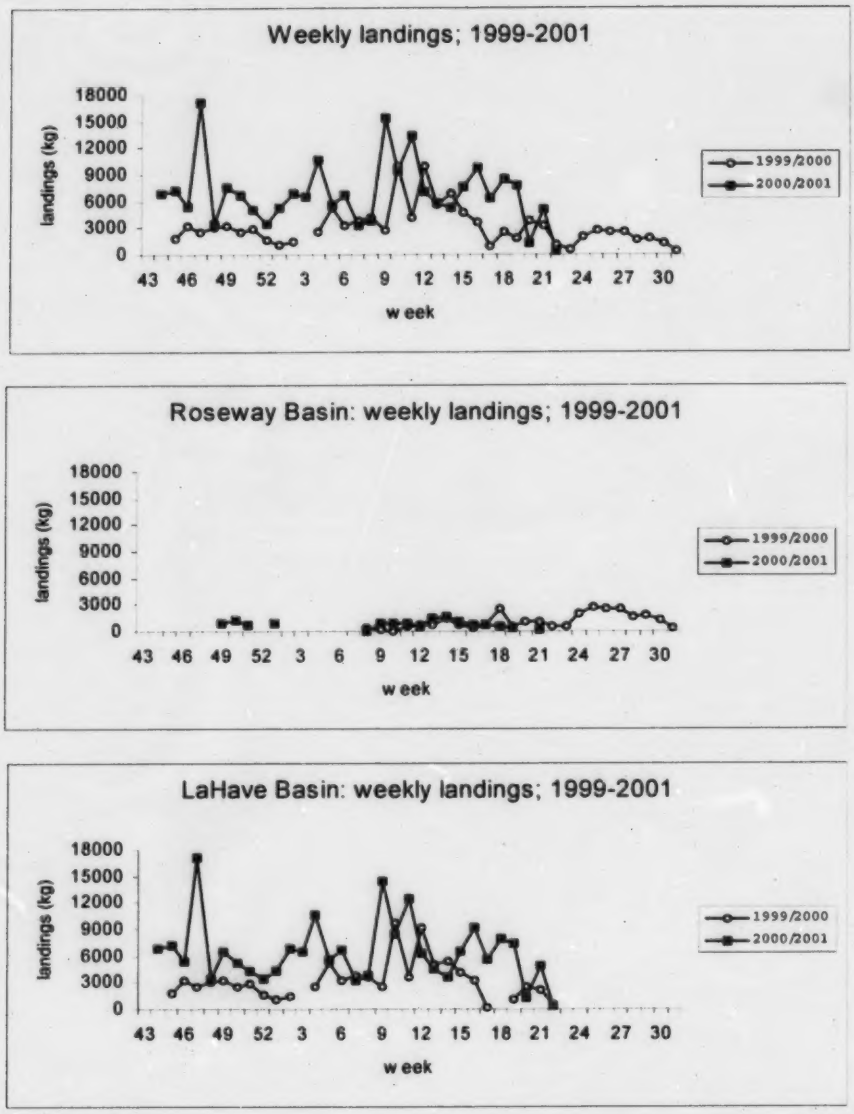

Figure 6. Weekly landings for Snow Crab in Area 4X for the 1999/2000 and 2000/2001 seasons.

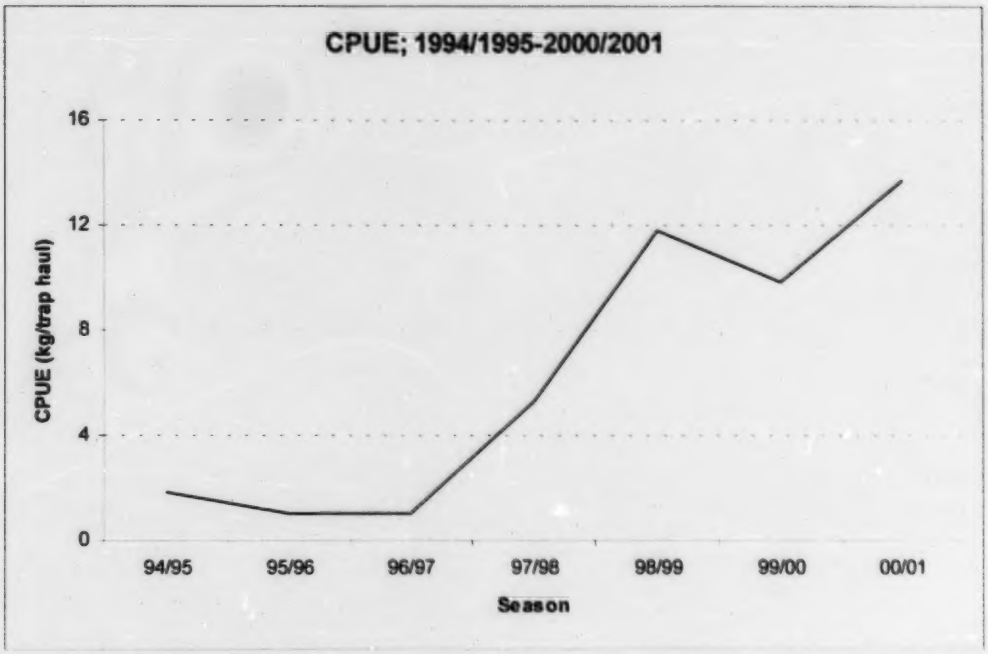

Figure 7. Seasonal catch per unit of effort for Crab Fishing Area 4X from 1994 to May 24, 2001.

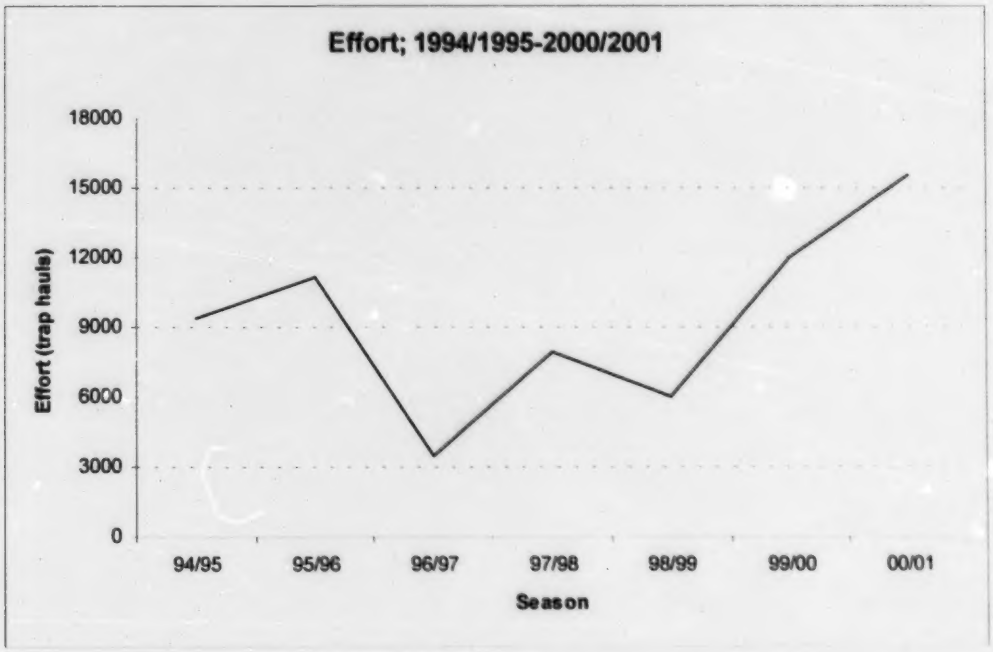

Figure 8. Seasonal fishing effort for Crab Fishing Area 4X from 1994 to May 24, 2001.

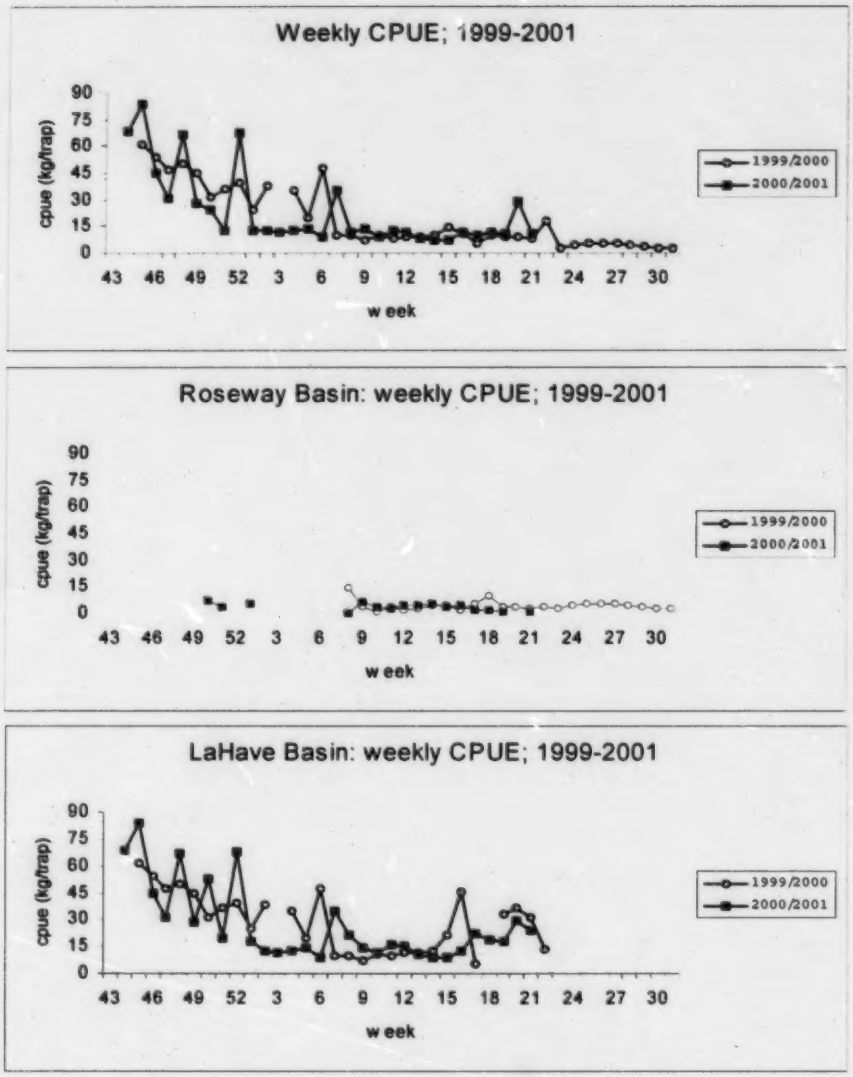

Figure 9. Weekly catch rate for Snow Crab in Area 4X for the 1999/2000 and 2000/2001 seasons.

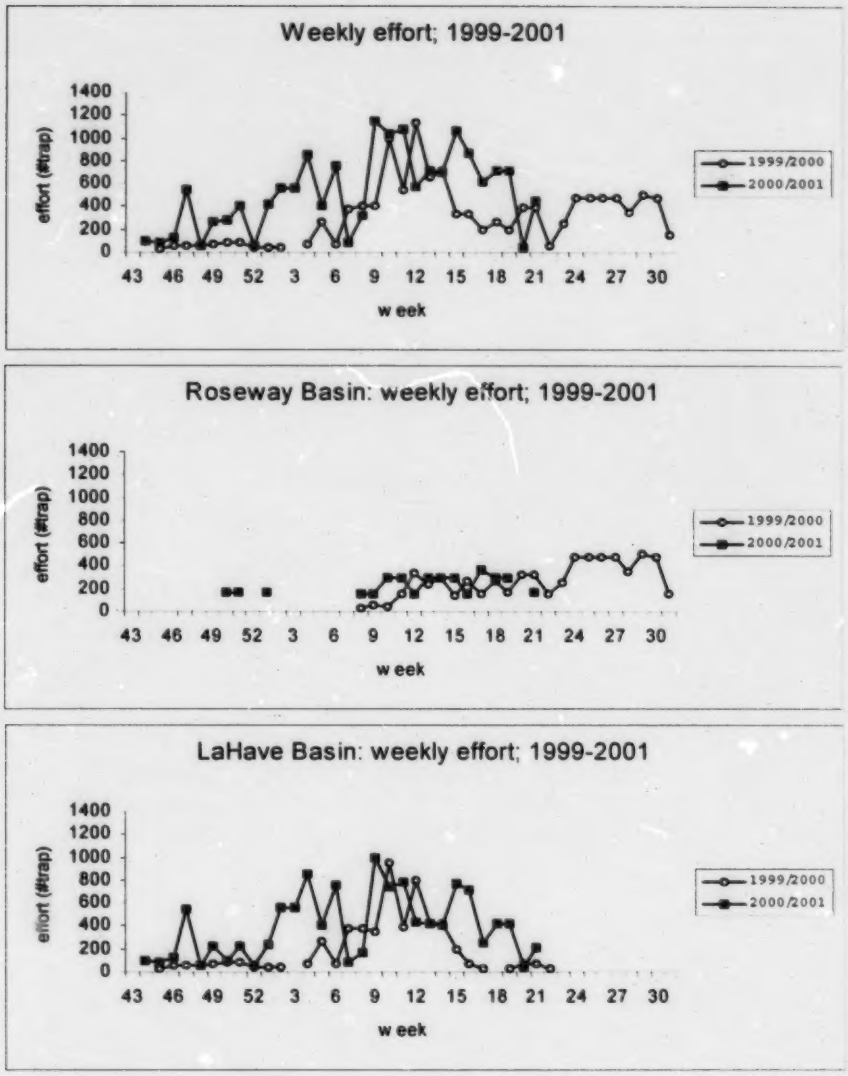

Figure 10. Weekly effort for Snow Crab in Area 4X for the 1999/2000 and 2000/2001 seasons.

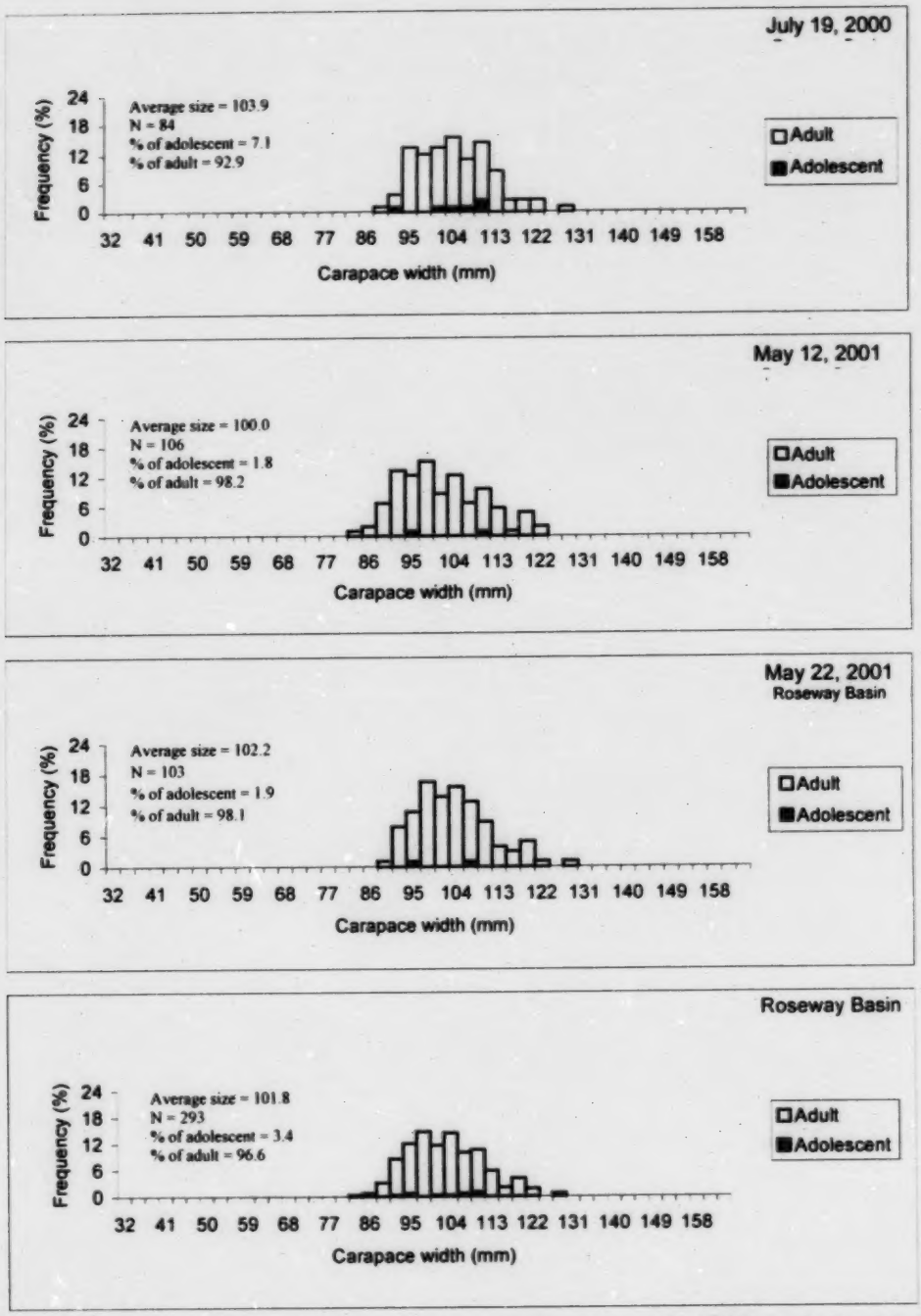

Figure 11. Size frequency distribution from the sea sampling (traps) in 2000 carried out in Roseway Basin area for Snow Crab.

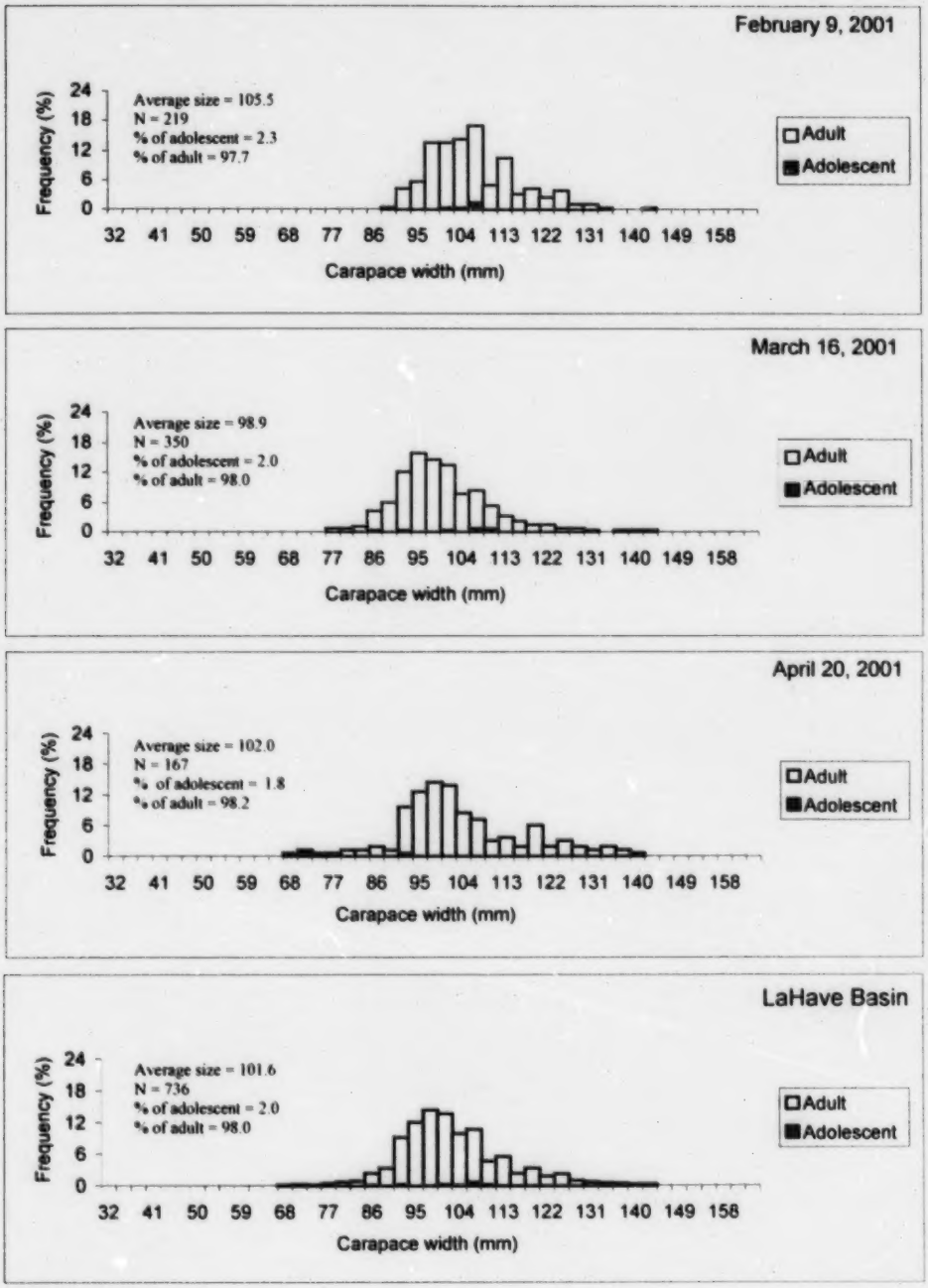

Figure 12. Size frequency distribution from the sea sampling (traps) in 2001 carried out in LaHave Basin area for Snow Crab.

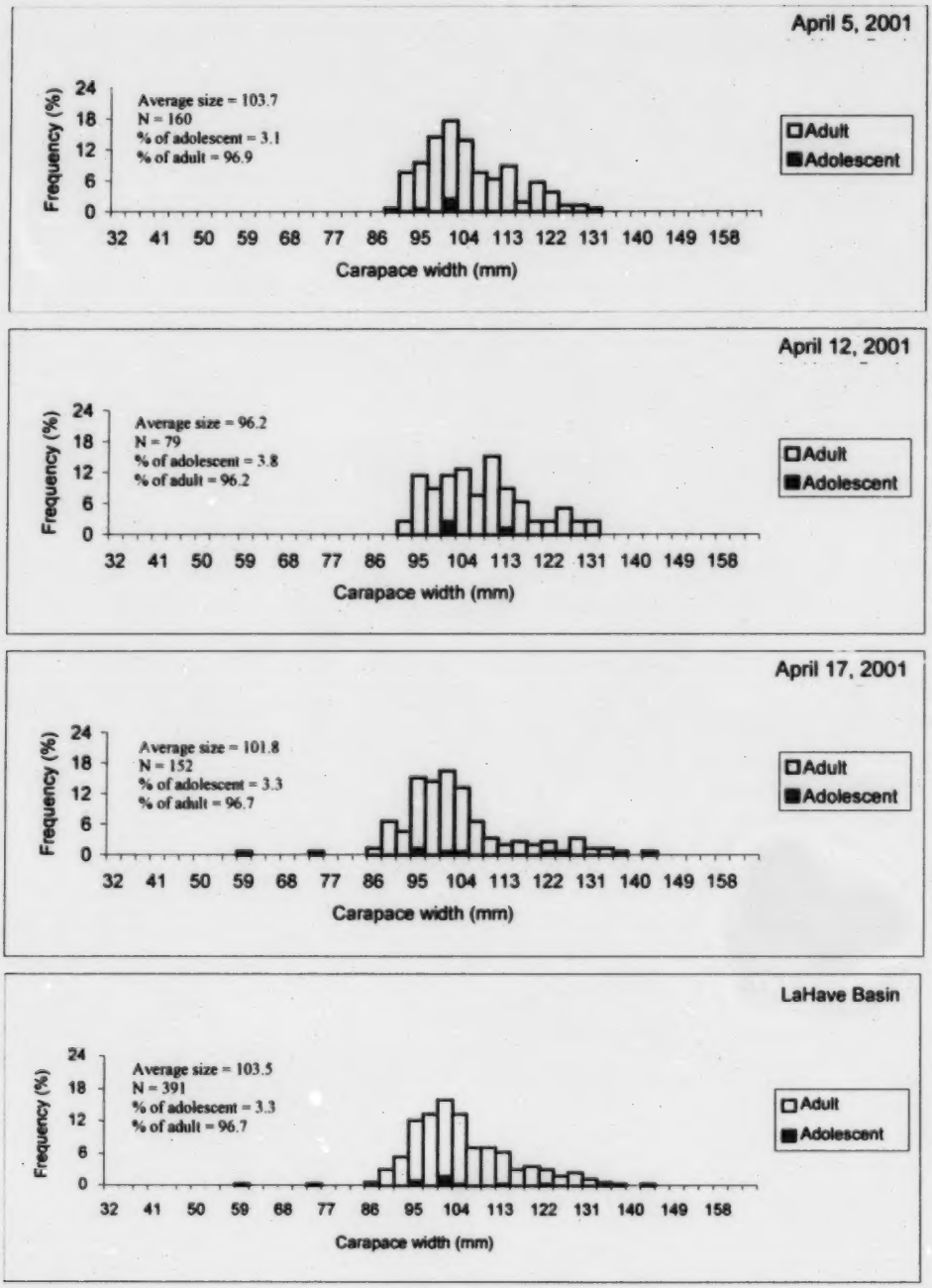

Figure 13. Size frequency distribution from the sea sampling (strings) in 2001 carried out in LaHave Basin area for Snow Crab.

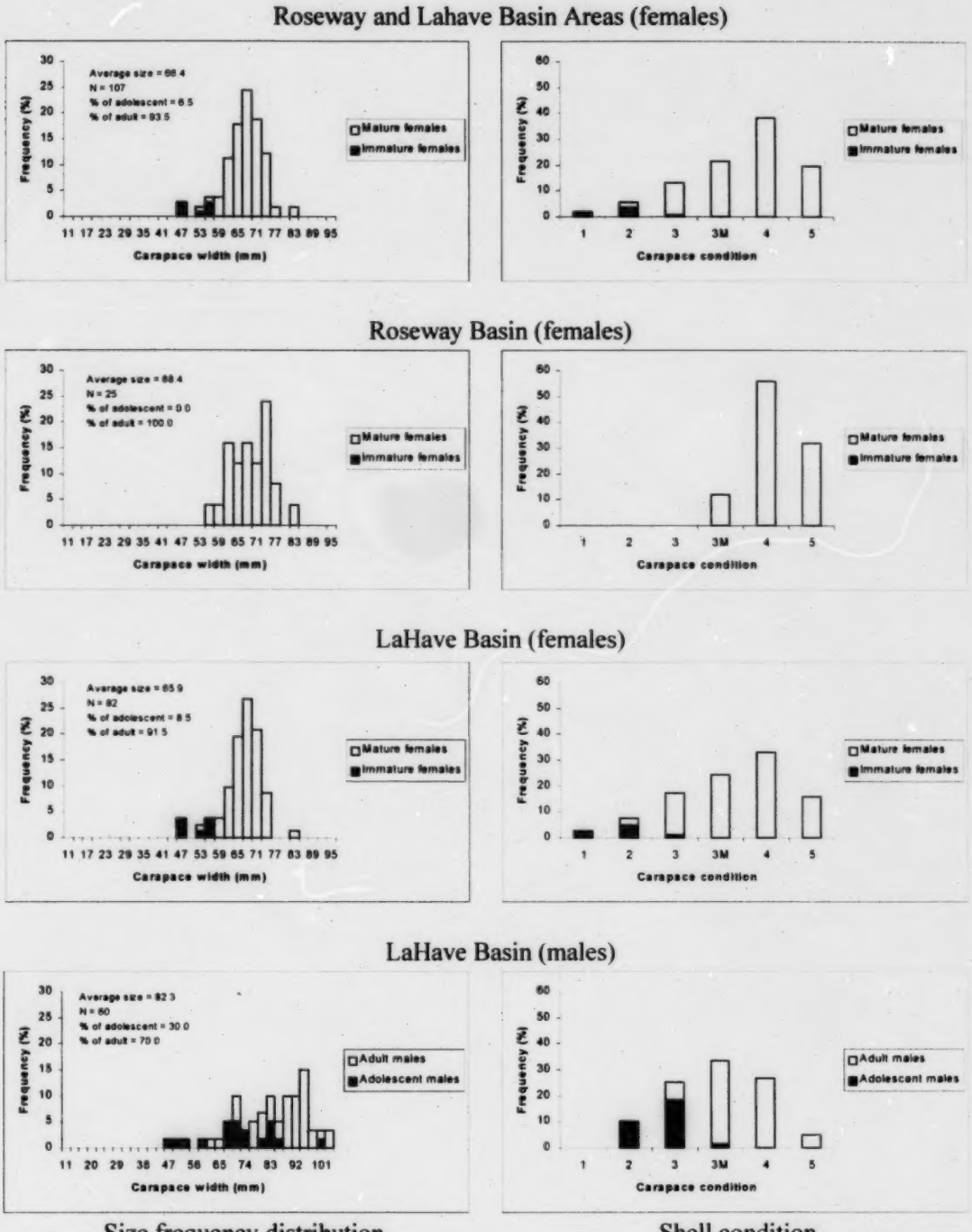

Figure 14. Size frequency distribution and shell condition from the sea sampling (shrimp traps) in 2000 carried out in southwestern Nova Scotia for snow crab.

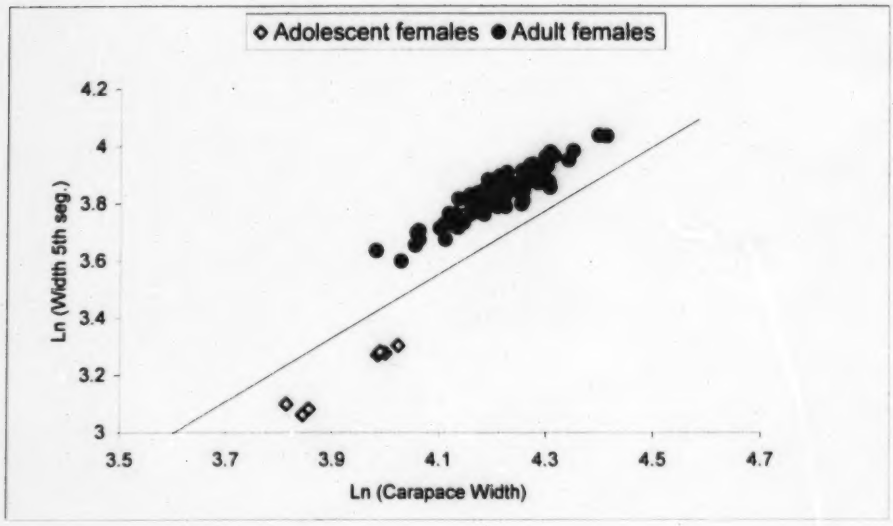

Figure 15. Southern Gulf of St. Lawrence female discriminant function applied to Crab Fishing Area 4X from the sea sampling (shrimp traps) in 2000.

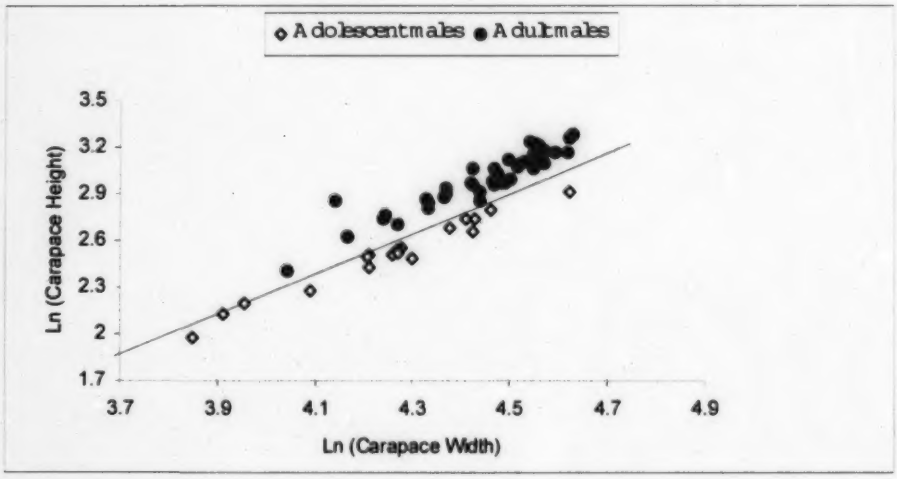

Figure 16. Eastern Nova Scotia male discriminant function applied to Crab Fishing Area 4X from the sea sampling (shrimp traps) in 2000.

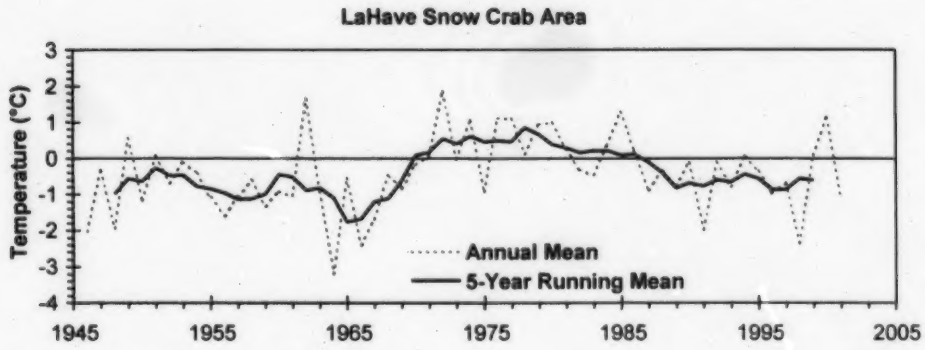

Figure 17. Annual means near-bottom temperatures in LaHave fishing grounds in Area 4X.

Appendix 1

Classification of carapace stages based on carapace condition, durometer reading and corresponding approximate age after terminal molt (Moriyasu et al. 1998).

Category	Stage	Durometer reading	Carapace condition	Approximate age after terminal molt
New soft	I	< 68	brightly colored, iridescent, soft, no epibionts, chelae easily bent.	0-5 months
Clean	II	variable	brightly colored, some iridescence, may have epibionts, chelae not easily bent	5 months- 1 year
Inter-mediate	III	> 68	dull brown dorsally and yellow-brown ventrally, no irridescence, shell abrasion evident, epibionts.	8 months -3 years
Old	IV	> 68	carapace very dirty but hard, decay may be present at leg joints, epibionts removable at processing plant.	2 - 5 years
Very old	V	variable	carapace very dirty and may be soft (durometer reading < 68), progression of decay may be evident, epibionts not removable at processing plant.	4-6 years

Appendix 2

Table 1. Annual landings, catch rate and effort statistics of Snow Crab (*Chionoecetes opilio*) in Area 4X off southwestern Nova Scotia (NAFO 4X), 1994-2001.

Year	Active Licences/permits	Total* landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (trap haul)
1994	4	0.1	1.6	82
1995	4	18	1.5	12,528
1996	4	11	1.0	10,717
1997	1	2	2.3	700
1998	4	42	5.4	7,893
1999	4	91	13.4	6,826
2000	4	160	11.5	13,865
2001**	8	287	15.2	18,872
Average (all)		76.4	6.5	8,935
Average (99-01)		179.3	13.4	13,188

* Total annual landing statistics provided by DFO-Statistics, Halifax.
** Up to December 4, 2001

Appendix 2

Table 2. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X, 1999.

Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Jan. 3	3,275	?	?
Jan. 10	1,113	?	?
Jan. 17	2,723	?	?
Jan. 24	2,139	7.7	277
Jan. 31	1,923	18.6	116
Feb. 7	4,806	21.4	225
Feb. 14	5,341	24.5	218
Feb. 21	5,584	17.0	328
Feb. 28	4,253	10.0	425
Mar. 7	160	14.5	11
Mar. 14	3,228	7.8	412
Mar. 21	4,937	6.1	813
Mar. 28	3,835	11.7	329
Apr. 4	5,500	8.5	648
Apr. 11	3,363	6.7	499
Apr. 18	3,488	10.0	350
Apr. 25	3,313	18.5	179
May 2	2,395	39.9	60
May 9	1,325	44.2	30
May 16	1,469	49.0	30
May 23	-	-	-
May 30	-	-	-
June 6	713	4.8	149
June 13	763	2.6	298
June 20	288	1.9	150
June 27	190	1.3	150
July 4	-	-	-
July 11	838	9.4	89
July 18	2,181	31.2	70
July 25	1,230	30.8	40
Aug. 1	-	-	-
Aug. 8	-	-	-
Aug. 15	-	-	-
Aug. 22	-	-	-
Aug. 29	-	-	-
Sept. 5	-	-	-
Sept. 12	-	-	-
Sept. 19	-	-	-
Sept. 26	-	-	-
Oct. 3	-	-	-
Oct. 10	-	-	-
Oct. 17	-	-	-
Oct. 24	-	-	-
Oct. 31	-	-	-
Nov. 7	1,841	61.4	30
Nov. 14	3,241	54.0	60
Nov. 21	2,587	47.0	55
Nov. 28	3,008	50.1	60
Dec. 5	3,272	44.8	73
Dec. 12	2,521	31.5	80
Dec. 19	2,893	36.2	80
Dec. 26	1,569	39.2	40
Total*	91,305	13.4	6,826

*Total annual landings

Appendix 2

Table 3. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X, 2000.

Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Jan. 2	1,105	24.6	45
Jan. 9	1,519	38.0	40
Jan. 16	-	-	-
Jan. 23	2,603	34.7	75
Jan. 30	5,134	19.6	262
Feb. 6	3,325	47.5	70
Feb. 13	3,713	9.8	380
Feb. 20	4,055	9.9	410
Feb. 27	2,713	6.8	400
Mar. 5	9,812	9.9	995
Mar. 12	4,140	7.7	540
Mar. 19	9,934	8.7	1,136
Mar. 26	5,665	8.6	662
Apr. 2	6,830	9.6	708
Apr. 9	4,693	14.0	335
Apr. 16	3,605	10.9	332
Apr. 23	957	5.0	191
Apr. 30	2,599	10.0	261
May 7	1,722	8.7	197
May 14	3,692	9.4	392
May 21	3,194	8.1	392
May 28	1,075	17.9	60
June 4	629	2.5	256
June 11	1,970	4.1	483
June 18	2,620	5.4	483
June 25	2,563	5.3	483
July 2	2,468	5.2	477
July 9	1,705	4.8	353
July 16	1,734	3.4	510
July 23	1,314	2.8	474
July 30	445	2.8	158
Aug. 6	-	-	-
Aug. 13	-	-	-
Aug. 20	-	-	-
Aug. 27	-	-	-
Sept. 3	-	-	-
Sept. 10	-	-	-
Sept. 17	-	-	-
Sept. 24	-	-	-
Oct. 1	-	-	-
Oct. 8	-	-	-
Oct. 15	-	-	-
Oct. 22	-	-	-
Oct. 29	6,826	68.3	100
Nov. 5	7,138	84.0	85
Nov. 12	5,441	44.9	121
Nov. 19	17,115	31.0	552
Nov. 26	3,333	66.7	50
Dec. 3	7,476	28.3	264
Dec. 10	6,584	23.9	275
Dec. 17	5,027	12.6	400
Dec. 24	3,364	67.3	50
Total*	159,837	11.5	13,865

*Total annual landings

Appendix 2

Table 4. Weekly landing, catch rate and effort statistics for Snow Crab in Area 4X, 2001.

Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Dec. 31	5,245	12.6	415
Jan. 7	6,857	12.4	555
Jan. 14	6,399	11.3	565
Jan. 21	10,648	12.5	850
Jan. 28	5,573	13.9	400
Feb. 4	6,744	9.0	750
Feb. 11	3,157	35.1	90
Feb. 18	3,748	11.7	319
Feb. 25	15,254	13.3	1,144
Mar. 4	9,401	9.1	1,036
Mar. 11	13,309	12.4	1,077
Mar. 18	6,977	12.1	579
Mar. 25	5,822	8.1	719
Apr. 1	5,270	7.5	700
Apr. 8	7,565	7.1	1,064
Apr. 15	9,761	11.3	864
Apr. 22	6,287	10.2	614
Apr. 29	8,400	11.7	717
May 6	7,661	10.7	715
May 13	1,309	29.1	45
May 20	5,055	11.2	453
May 27	321	?	?
June 3	-	-	-
June 10	-	-	-
June 17	-	-	-
June 24	-	-	-
July 1	-	-	-
July 8	-	-	-
July 15	-	-	-
July 22	-	-	-
July 29	-	-	-
Aug. 5	-	-	-
Aug. 12	-	-	-
Aug. 19	-	-	-
Aug. 26	-	-	-
Sept. 2	-	-	-
Sept. 9	-	-	-
Sept. 16	-	-	-
Sept. 23	-	-	-
Sept. 30	-	-	-
Oct. 7	-	-	-
Oct. 14	-	-	-
Oct. 21	-	-	-
Oct. 28	11,541	35.0	330
Nov. 4	34,801	24.4	1,424
Nov. 11	23,096	28.8	801
Nov. 18	46,673	26.8	1,742
Nov. 25	15,401	59.0	261
Dec. 2	4,553	9.1	500
Dec. 9	-	-	-
Dec. 16	-	-	-
Dec. 23	-	-	-
Total*	286,828	15.2	18,872

*Total annual landings

Appendix 3

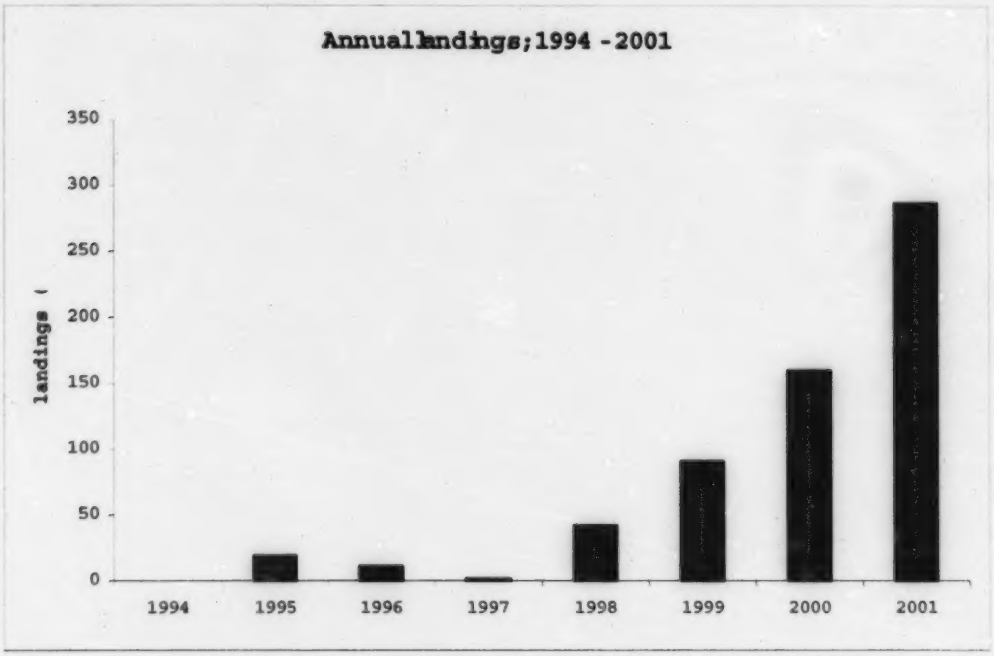

Figure 1. Annual Snow Crab landings (t) in southwestern Nova Scotia from 1994 to December 4, 2001.

Appendix 3

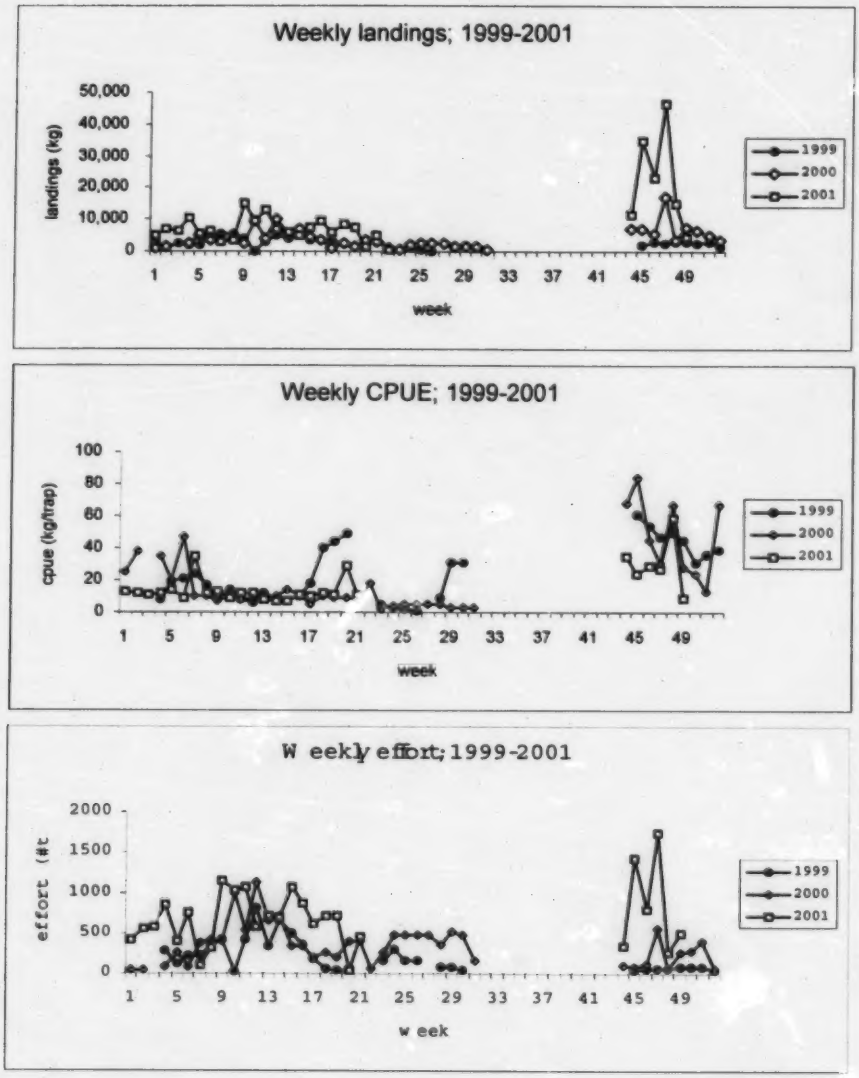

Figure 2. Weekly landings, catch rate and effort for Snow Crab in Area 4X from 1999 to December 4, 2001.

Appendix 3

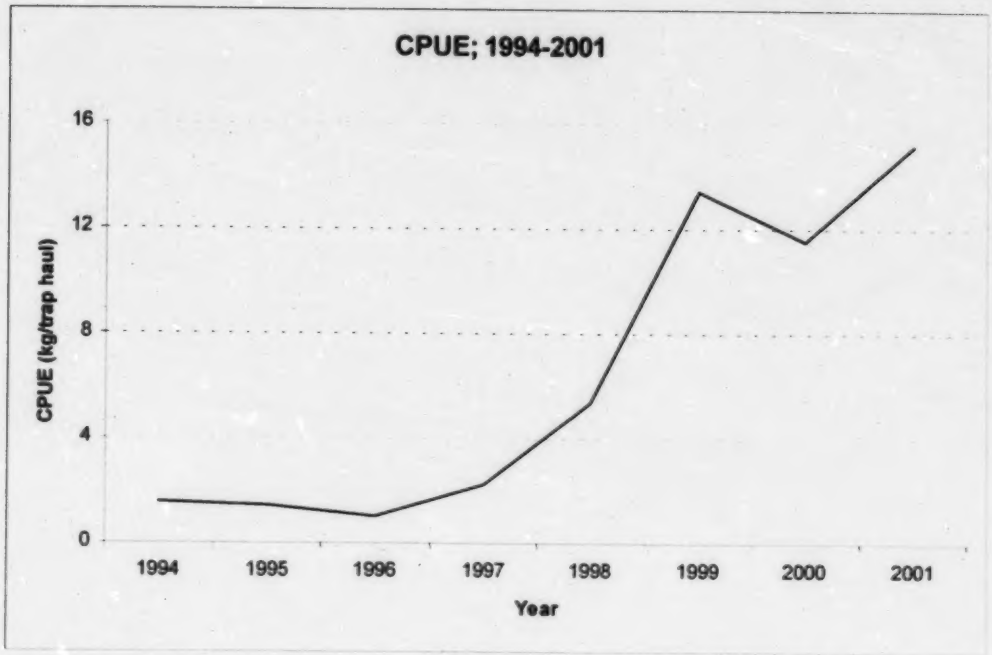

Figure 3. Annual catch per unit of effort for Crab Fishing Area 27 from 1994 to December 4, 2001.

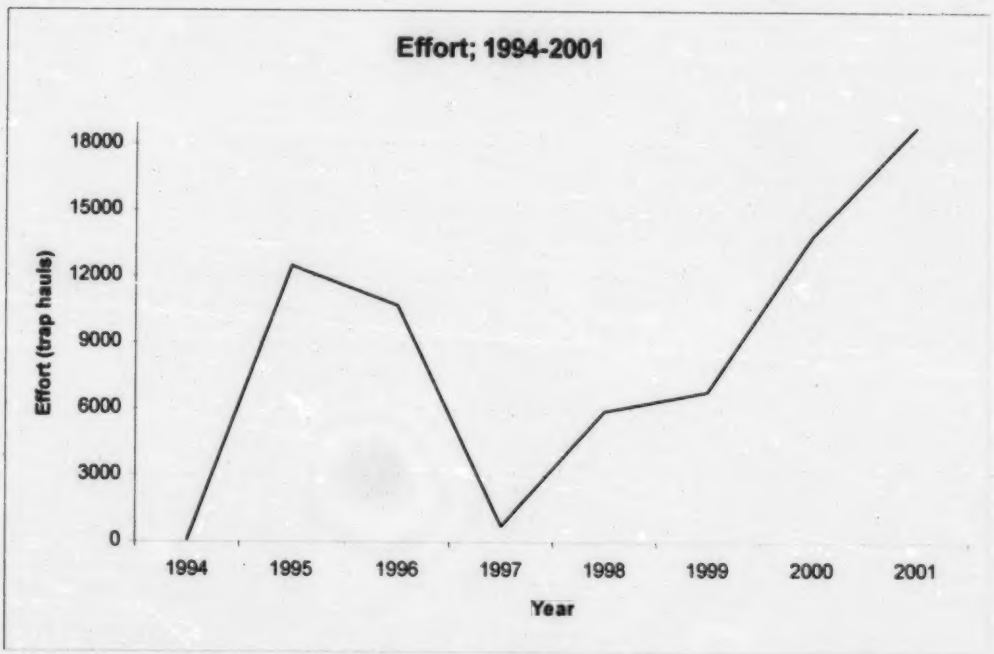

Figure 4. Annual fishing effort for Crab Fishing Area 27 from 1994 to December 4, 2001.

Appendix 4

Table 1. Catch composition, in number, from at-sea samples (number of trips and traps sampled) in the Roseway Basin Area for southwestern Nova Scotia in 2000-2001.

a) Catch composition for July 19, 2000 in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	Adult	
1	13	< 95 mm	1	7	0	0	1	7	8
		> 95 mm	3	69	2	2	5	71	76
		total	4	76	2	2	6	78	84

b) Catch composition for May 12, 2001in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	Adolescent	Adult	
1	22	< 95 mm	1	33	0	0	1	33	34
		> 95 mm	1	71	0	0	1	71	72
		total	2	104	0	0	2	104	106

c) Catch composition for May 22, 2001in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	Adolescent	Adult	
1	41	< 95 mm	0	15	0	0	0	15	15
		> 95 mm	2	86	0	0	2	86	88
		total	2	101	0	0	2	101	103

d) Catch composition in Roseway Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	Adolescent	Adult	
3	76	< 95 mm	2	55	0	0	2	55	57
		> 95 mm	6	226	2	2	8	228	236
		total	8	281	2	2	10	283	293

Appendix 4

Table 2. Catch composition, in number, from at-sea samples (number of trips and traps sampled) in the LaHave Basin Area for southwestern Nova Scotia in 2000-2001.

a) Catch composition for February 9, 2001 in LaHave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	Adult	
1	13	< 95 mm	0	18	0	0	0	18	18
		> 95 mm	5	194	0	2	5	196	201
		total	5	212	0	2	5	214	219

b) Catch composition for March 16, 2001 in LaHave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	Adult	
1	9	< 95 mm	2	115	0	2	2	117	119
		> 95 mm	5	226	0	0	5	226	231
		total	7	341	0	2	7	343	350

c) Catch composition for April 20, 2001 in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	Adult	
1	21	< 95 mm	2	34	1	7	3	41	44
		> 95 mm	0	107	0	16	0	123	123
		total	2	141	1	23	3	164	167

d) Catch composition in Lahave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	Adult	
3	43	< 95 mm	4	167	1	9	5	176	181
		> 95 mm	10	527	0	18	10	545	555
		total	14	694	1	27	15	721	736

Appendix 4

Table 3. Catch composition, in number, from at-sea samples (number of trips and strings* sampled) in the LaHave Basin Area for southwestern Nova Scotia in 2001.

a) Catch composition for April 5, 2001 in LaHave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	adult	adolescent	adult	adolescent	adult	
1	5	< 95 mm	1	18	0	0	1	18	19
		> 95 mm	1	137	3	0	4	37	141
		total	2	155	3	0	5	155	160

b) Catch composition for April 12, 2001 in LaHave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	Adult	adolescent	adult	adolescent	adult	
1	2	< 95 mm	0	8	0	0	0	8	8
		> 95 mm	2	68	1	0	3	68	71
		total	2	76	1	0	3	76	79

c) Catch composition for April 17, 2001 in LaHave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	adult	adolescent	adult	adolescent	adult	
1	5	< 95 mm	0	28	2	6	2	34	36
		> 95 mm	2	89	1	24	3	113	116
		total	2	117	3	30	5	147	152

d) Catch composition in LaHave Basin Area.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	string*		adolescent	adult	adolescent	adult	adolescent	adult	
3	12	< 95 mm	1	54	2	6	3	60	63
		> 95 mm	5	294	5	24	10	318	328
		total	6	348	7	30	13	378	391

*A string can have 10 to 21 traps.